ScienceDaily

周三, 05 9月 2018

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Latest Science News

Breaking science news and articles on global warming, extrasolar planets, stem cells, bird flu, autism, nanotechnology, dinosaurs, evolution -- the latest discoveries in astronomy, anthropology, biology, chemistry, climate and environment, computers, engineering, health and medicine, math, physics, psychology, technology, and more -- from the world's leading universities and research organizations.

- **Body clock link to steroids discovered** [周三, 05 9月 04:46]
  Scientists have discovered that the time of day influences the way mice respond to steroids. Researchers found that out of 752 genes which regulate lungs in mice, 230 genes work only in the day and 197 only at night.
- **No evidence that moral reminders reduce cheating behavior, replication effort concludes** [周三, 05 9月 04:46]
  Scientists report they were unable to reproduce the results of a well-known study showing that people are less likely to cheat on a task after making a list of the Ten Commandments.
- **Focused delivery for brain cancers** [周三, 05 9月 04:46]
  Medical researchers are working toward a more focused drug delivery system that could target tumors lodged in the brainstem, the body's most precious system.
- **Antioxidant reduces risk for second heart attack, stroke** [周三, 05 9月 04:46]
  Doctors have long known that in the months after a heart attack or stroke, patients are more likely to have another attack or stroke. Now, an article explains what happens inside blood vessels to increase risk -- and suggests a new way to treat it.
- **Hormone therapy can make prostate cancer worse, study finds** [周三, 05 9月 04:46]
  Scientists have discovered how prostate cancer can sometimes withstand and outwit a standard hormone therapy, causing the cancer to spread. Their findings also point to a simple blood test that may help doctors predict when this type of hormone therapy resistance will occur.
- **High precision microbial population dynamics under cycles of feast and famine** [周三, 05 9月 04:45]
  Scientists have produced the most precise picture to date of population dynamics in fluctuating feast-or-famine conditions. Biological physicists found that bacterial population density is a function of both the frequency and the amplitude of nutrient fluctuations.
- **California: Global warming, El Niño could cause wetter**

winters, drier conditions in other months [周三, 05 9月 03:04]
New research indicates that what future precipitation California gets will be pretty much limited to the winter months -- think deluge-type rainfall rather than snow -- and non-winter months will be even dryer than usual, with little or no rain at all.

- **Giving tortoises a 'head start'** [周三, 05 9月 03:04]
  Research indicates that head-starting -- raising a species in captivity and releasing it into a protected habitat after it has grown large enough to be less vulnerable to predators -- is a useful intervention for boosting the state's gopher tortoise population.

- **Parsing natural climate variability from human-caused climate change** [周三, 05 9月 03:03]
  A new study says pink noise may be the key to separating out natural climate variability from climate change that is influenced by human activity.

- **Ultracold atoms used to verify 1963 prediction about 1D electrons** [周三, 05 9月 03:03]
  Atomic physicists have verified a key prediction from a 55-year-old theory about one-dimensional electronics that is increasingly relevant thanks to Silicon Valley's inexorable quest for miniaturization.

- **Why we stick to false beliefs: Feedback trumps hard evidence** [周三, 05 9月 03:03]
  Ever wonder why flat earthers, birthers, climate change and Holocaust deniers stick to their beliefs in the face of overwhelming evidence to the contrary? New findings suggest that feedback, rather than hard evidence, boosts people's sense of certainty when learning new things or trying to tell right from wrong.

- **Superbug discovery renews hope for antibiotic treatment** [周三, 05 9月 02:06]
  Bacteria that were thought to be resistant to a powerful antibiotic may be susceptible to treatment after all, research has found.

- **Dementia symptoms peak in winter and spring, study finds** [周三, 05 9月 02:06]
  Adults both with and without Alzheimer's disease have better cognition skills in the late summer and early fall than in the winter and spring, according to a new study.

- **Fossil teeth show how Jurassic reptiles adapted to changing seas** [周三, 05 9月 02:06]
  Marine predators that lived in deep waters during the Jurassic Period thrived as sea levels rose, while species that dwelled in the shallows died out, research suggests.

- **New smart materials could open new research field** [周三, 05 9月 02:06]
  A group of new smart materials has the potential to significantly improve the efficiency of fuel burn in

jet engines, cutting the cost of flying. The materials, which could also reduce airplane noise over residential areas, have additional applications in a variety of other industries.

- **State-of-the-art imaging techniques reveal heightened detail and beauty of vertebrate life** [周三, 05 9月 02:06]
  A mingling of science and art, the next-generation photographs of vertebrate skeletons are at once fascinating, eerie, intricate and exquisite.

- **What could have extended human lifespan? Researchers identify 25 genetic changes** [周三, 05 9月 02:06]
  A new method has made it possible to identify 25 parallel mutations located in genes associated with wound healing, blood coagulation and cardiovascular disorders. The results could help to develop new drugs to treat aging-related diseases. The research confirms the theory that some genes that help us in the initial stages of life are harmful to us once the reproductive stage has ended.

- **Peering into private life of atomic clusters -- using the world's tiniest test tubes** [周三, 05 9月 02:06]
  Researchers have achieved time-resolved imaging of atomic-scale dynamics and chemical transformations promoted by metal nanoclusters.

- **Novel strategy shows promise for earlier detection of Alzheimer's disease** [周三, 05 9月 02:05]
  Finding an effective way to identify people with mild cognitive impairment who are most likely to go on to develop Alzheimer's disease has eluded researchers for years. But now, a team of researchers has devised a novel strategy that could do just that.

- **Earlier diagnosis, potential therapy for Huntington's disease suggested in new research** [周三, 05 9月 02:05]
  A new study suggests that Huntington's disease may take effect much earlier in life than was previously believed, and that a new drug may be key in controlling the disease.

- **Measuring the nanoworld** [周三, 05 9月 02:05]
  Researchers establish a benchmark for accurate determination of internal dimensions within individual molecules.

- **New technology improves hydrogen manufacturing** [周三, 05 9月 02:05]
  Researchers have demonstrated high-performance electrochemical hydrogen production at a lower temperature than had been possible before.

- **Hormone link between diabetes and hypertension identified** [周三, 05 9月 02:05]
  Increased levels of the hormone aldosterone, already associated with hypertension, can play a significant role in the development of diabetes, particularly among certain racial groups, researchers report.

- **AI beats doctors at predicting heart disease deaths** [周三, 05 9月 02:05]
  A model developed using artificial intelligence is better at predicting risk of death in patients with heart disease than models designed by medical experts, a new study shows.
- **DNA technology provides novel strategy for delivery of complex anti-HIV agent** [周三, 05 9月 02:05]
  Scientists have applied synthetic DNA technology to engineer a novel eCD4-Ig anti-HIV agent and to enhance its potency in vivo, providing a new simple strategy for constructing complex therapeutics for infectious agents as well as for diverse implications in therapeutic delivery.
- **You act most like 'you' in a time crunch, study finds** [周三, 05 9月 02:05]
  When they must act quickly, selfish people are likely to act more selfishly than usual, while pro-social people behave even more pro-socially, a new study found.
- **The gens isiaca in Hispania: Egyptian gods in Roman Spain** [周二, 04 9月 23:47]
  Researchers have developed a geo-localized database which enables archaeological pieces from ancient religions to be located on the Iberian Peninsula. This platform, named "The gens isiaca in Hispania", provides a catalogue with more than 200 remains from the Roman age on Isis and other Egyptian gods.
- **Reducing nitrogen inputs prevents algal blooms in lakes** [周二, 04 9月 23:47]
  For decades, experts have debated whether reducing the amount of nitrogen flowing into lakes can improve water quality in the long-term, even though blue-green algae can bind nitrogen from the air. Scientists have now shown that the amount of atmospheric nitrogen bound by blue-green algae is far too small to be used as an argument against the ecologically necessary reduction of nitrogen inputs.
- **Attention network plays key role in restoring vision after brain damage** [周二, 04 9月 23:47]
  About one-third of patients who have suffered a stroke end up with low vision, losing up to half of their visual field. This partial blindness was long considered irreversible, but recent studies have shown that vision training after optic nerve and brain damage can help restore or improve vision. A new study reports on key mechanisms of vision restoration: attention.
- **A breakthrough for Australia's fish** [周二, 04 9月 23:47]
  A research team has made a breakthrough that could help dwindling numbers of Australian freshwater fish species. Researchers say the innovation will allow small and young fish to get past barriers like culverts.
- **Severely traumatized refugees may not necessarily develop PTSD** [周二, 04 9月 23:47]
  Heavily traumatized people such as refugees fleeing war, torture and natural catastrophes may not necessarily develop posttraumatic stress disorder (PTSD), a new study reveals.

- **Individual metering of heating consumption could lead to savings of up to 20 percent** [周二, 04 9月 23:47]
  Researchers have conducted a detailed study of the changes in habits brought about by individual metering and charging of heating and domestic hot water in a community of residents.
- **A quantum gate between atoms and photons may help in scaling up quantum computers** [周二, 04 9月 23:47]
  The quantum computers of the future will be able to perform computations that cannot be done on today's computers. These may likely include the ability to crack the encryption that is currently used for secure electronic transactions, as well as the means to efficiently solve unwieldy problems in which the number of possible solutions increases exponentially.
- **Boosting gravitational wave detectors with quantum tricks** [周二, 04 9月 23:47]
  A group of scientists will soon start developing a new line of technical equipment in order to dramatically improve gravitational wave detectors. If the scientists are able to improve the gravitational wave detectors as much as they 'realistically expect can be done,' the detectors will be able to monitor and carry out measurements in an eight times bigger volume of space than what is currently possible.
- **New way to see dirty underside of glaciers** [周二, 04 9月 23:47]
  Accurate projections of sea level rise require sophisticated models for glacier flow, but current approaches do a poor job capturing the physical processes that control how fast glaciers slide over sediments, according to researchers. In a new study, they've proposed a theoretical approach that sheds light on the dirty, dark undersides of glaciers and improve the modeling of ice flow.
- **Quantum weirdness in 'chicken or egg' paradox** [周二, 04 9月 23:47]
  The 'chicken or egg' paradox was first proposed by philosophers in Ancient Greece to describe the problem of determining cause-and-effect. Now, a team of physicists has shown that, as far as quantum physics is concerned, the chicken and the egg can both come first.
- **Telescope maps cosmic rays in Large and Small Magellanic Clouds** [周二, 04 9月 23:47]
  A radio telescope in outback Western Australia has been used to observe radiation from cosmic rays in two neighbouring galaxies, showing areas of star formation and echoes of past supernovae.
- **Breaking osteoporosis: New mechanism activates bone-building cells** [周二, 04 9月 23:47]
  The number of osteoporosis medications that promote bone formation are few compared to those that suppress bone resorption. Researchers have discovered that the gene SIRT7 is important for bone formation, and have succeeded in finding a new mechanism to activate gene functions essential for bone formation.
- **Simulations reveal role of calcium in titanium implant**

acceptance [周二, 04 9月 23:47]
Titanium-based materials are widely used in medical implant technology, and coating the surface of titanium materials with biologically active molecules has recently shown promise to improve how cells adhere to implants. The mechanisms behind how peptides stick to titanium, however, are not fully understood. Researchers have now found how calcium ions present at the interface between titanium oxide and tissues affect how well peptides bind to the metal.

- **Key differences between the exercise-trained heart and failing heart** [周二, 04 9月 23:47]
  Scientists have examined what is happening to the lipids in the heart and circulating blood plasma during exercise compared to a failing heart as a novel way to advance prediction and treatment of heart failure.

- **Coral bleaching on Great Barrier Reef not limited to shallow depths** [周二, 04 9月 23:47]
  A new study demonstrates that the recent mass coral bleaching on the Great Barrier Reef was not restricted to shallow depths, but also impacted deep reefs. Although deep reefs are often considered a refuge from thermal anomalies, the new research highlights limitations to this role and argues that both shallow and deep reefs are under threat of mass bleaching events.

- **New clues found to understanding relapse in breast cancer** [周二, 04 9月 23:47]
  A large genomic analysis has linked certain DNA mutations to a high risk of relapse in estrogen receptor positive breast cancer, while other mutations were associated with better outcomes, according to researchers.

- **New mechanism for how ALS disease evolves** [周二, 04 9月 23:47]
  Researchers have found a mechanism for how amyotrophic lateral sclerosis (ALS) evolves. The discovery concerns how proteins with a defect structure spread the deformation to other proteins.

- **How much insects eat** [周二, 04 9月 23:47]
  A first-of-its-kind study used herbarium specimens to track insect herbivory across more than a century, and found that, across four species -- shagbark hickory (Carya ovata), swamp white oak (Quercus bicolor), showy tick trefoil (Desmodium canadense) and wild lowbush blueberry (Vaccinium angustifolium) -- specimens collected in the early 2000s were 23 percent more likely to be damaged by insect herbivores than those collected in the early 1900s.

- **Increased chances of successful IVF with 18-20 eggs** [周二, 04 9月 22:32]
  The likelihood of childbirth after in vitro fertilization (IVF) treatment increases if 18 to 20 eggs are stimulated to mature in a woman's ovaries, new research shows. That is more eggs than the number aimed at in today's IVF treatments.

- **Veiled supernovae provide clue to stellar evolution** [周二, 04 9月 22:32]
  At the end of its life, a red supergiant star explodes in a hydrogen-rich supernova. By comparing observation results to simulation models, an international research team found that in many cases this

explosion takes place inside a thick cloud of circumstellar matter shrouding the star. This result completely changes our understanding of the last stage of stellar evolution.

- **Satellites more at risk from fast solar wind than a major space storm** [周二, 04 9月 22:32]
  Satellites are more likely to be at risk from high-speed solar wind than a major geomagnetic storm according to a new study.

- **Superradiance: Quantum effect detected in tiny diamonds** [周二, 04 9月 22:32]
  An atom gives off energy and causes many other atoms in its vicinity to emit light as well. This phenomenon is called 'superradiance'. For the first time, this phenomenon has now bean measured in a solid-state system, consisting of tiny diamonds with built-in nitrogen atoms.

- **Cathode fabrication for oxide solid-state batteries at room temperature** [周二, 04 9月 22:32]
  Researchers have successfully fabricated a lithium trivanadate (LVO) cathode thick film on a garnet-type oxide solid electrolyte using the aerosol deposition method. The LVO cathode thick-film fabricated on the solid electrolyte showed a large reversible charge and discharge capacity as high as 300 mAh/g and a good cycling stability at 100 ºC. This finding may contribute to the realization of highly safe and chemically stable oxide-based all-solid-state lithium batteries.

- **Powerful tools to solve challenges in bio- and circular economy** [周二, 04 9月 22:32]
  Researchers have developed an efficient synthetic biology toolbox for industry and research organizations. This toolbox enables, in an unprecedented way, engineering of a diverse range of yeasts and fungi.

Body clock link to steroids discovered: Time of day influences the way mice respond to steroids -- ScienceDaily

Professor David Ray, from The University of Manchester, lead the research which found that out of 752 genes which regulate lungs in mice, 230 genes work only in the day and only 197 at night.

And in the liver, where doctors have long thought that steroids are influential for many side effects, 1,702 genes regulate the organ in the day and a mere 299 at night in mice.

The research could one day have important implications on the way steroids -- one of the most common drugs in medicine -- are prescribed.

Published in the *Journal of Clinical Investigation*, the study is funded by the Wellcome Trust and the National Institutes of Health in the United States.

When Reverb? -- a molecule that controls the time of day effect is removed, the liver flips its genes so that more genes are regulated at night than during the day.

The removal of Reverb? also seemed to have a protective effect against the build up of fat in the liver -- known as fatty liver.

And that, says Professor Ray, could be important as daytime genes regulate glucose metabolism whereas night genes regulate fat metabolism.

Fatty liver is common, leads to diabetes, and can result in serious liver damage, including cirrhosis, if it progresses.

Professor Ray said: "Steroids are the most potent anti-inflammatory agent known to medicine. They are widely used and are very effective and used to treat a wide range of conditions.

"We can't yet say that this research confirms that taking steroids at different times of the day will impact on things like side effects.

"But this is clearly an exciting advance in the way we understand how steroids work."

He added: "There are experimental drugs which have been targeting Reverb? in animals.

"But now we hope to move on to measuring effectiveness and side effects on human tissue."

Story Source:

Materials provided by **University of Manchester**. *Note: Content may be edited for style and length.*

No evidence that moral reminders reduce cheating behavior, replication effort concludes -- ScienceDaily

Scientists report they were unable to reproduce the results of a well-known study showing that people are less likely to cheat on a task after making a list of the Ten Commandments. Their findings are published in a Registered Replication Report (RRR) in *Advances in Methods and Practices in Psychological Science*, a journal of the Association for Psychological Science.

The RRR, led by Bruno Verschuere from the University of Amsterdam and Ewout Meijer from the University of Maastricht, presented primary analyses of data from a total of 4,674 participants collected by 19 participating labs. The RRR aimed to replicate a 2008 study in which researchers Nina Mazar, On Amir, and Dan Ariely asked participants to recall either the Ten Commandments or 10 books they had read before completing a separate problem-solving task.

Data from the original study indicated that participants who had thought about the Ten Commandments, a moral reminder, were less likely to exaggerate when self-reporting how many problems they had solved compared with those who had been prompted to think about books. The findings provided support for self-concept maintenance theory, which holds that people seek personal gain so long as they can maintain a positive self-image while doing so.

Verschuere and Meijer developed the RRR protocol in consultation with Mazar, Amir, and Ariely, who provided the materials used in the original study and feedback on the study design. The protocol was preregistered and made publicly available online -- data from participating research teams were included in RRR analyses as long as the teams followed the protocol and met the preregistered criteria for inclusion.

The RRR data showed that the moral reminder had no observable effect on cheating behavior for participants who self-reported their problem-solving performance. Among the participants who had the opportunity to cheat, those who were asked to list the Ten Commandments reported solving about 0.11 more problems than their peers who listed books they had read. This stands in contrast with findings from the original study, which showed that participants who had thought about the Ten Commandments reported solving 1.45 fewer problems than their peers.

Although the participating research teams were located in various countries (including the US), there was little variation in their findings. This suggests that the features of the individual replication attempts and participants are unlikely to explain the overall RRR finding.

However, there may be other factors that could explain the divergent results.

"There are always differences between an original study and replication research. You cannot step in the same river twice," says Verschuere. "For instance, the original study was conducted more than a decade ago at an elite university. The perceived rewards, the perceived probability of getting caught and the perceived consequences of getting caught may have been different for participants in our replication study. But we also need to consider the possibility that the effect does not exist, and that the original result was a chance finding."

In a commentary accompanying the RRR, Amir, Mazar, and Ariely write that they are "grateful for the continued investigation and inquiry into a topic that we believe is not only important but also highly relevant in today's world."

They note that there are several possible reasons why the results detailed in the RRR might diverge from those of the original study, including the smaller testing group sizes. Also, participants may simply be more aware of research on dishonesty compared with those who participated in the original study a decade ago, they said.

According to Verschuere, the results show the importance of replication research.

"The psychological theory of cheating is very appealing, but we need more replication research to establish the reliability of its empirical basis," he concludes.

Focused delivery for brain cancers: Imaging, aerosols and pediatric neuro oncology come together to fight tumors -- ScienceDaily

A person's brainstem controls some of the body's most important functions, including heart beat, respiration, blood pressure and swallowing. Tumor growth in this part of the brain is therefore twice as devastating. Not only can such a growth disrupt vital functions, but operating in this area is so risky, many medical professionals refuse to consider it as an option.

New, interdisciplinary research in Washington University in St. Louis has shown a way to target drug delivery to just that area of the brain using noninvasive measures, bolstered by a novel technology: focused ultrasound.

The research comes from the lab of Hong Chen, assistant professor of biomedical engineering in the School of Engineering & Applied Science and assistant professor of radiation oncology at Washington University School of Medicine. Chen has developed a novel way in which ultrasound and its contrast agent -- consisting of tiny bubbles -- can be paired with intranasal administration, to direct a drug to the brainstem.

The research, which also included faculty from the Mallinckrodt Institute of Radiology and the Department of Pediatrics at the School of Medicine, along with the Department of Energy, Environmental & Chemical Engineering in the School of Engineering & Applied Science, was published online this week and will be in the Sept. 28 issue of the *Journal of Controlled Release*.

This technique may bring medicine one step closer to curing brain-based diseases such as diffuse intrinsic pontine gliomas (DIPG), a childhood brain cancer with a five-year survival rate of a scant two percent, a dismal prognosis that has remained unchanged over the past 40 years. (To add

perspective, the most common childhood cancer, acute lymphoblastic leukemia, has a five-year survival rate of nearly 90 percent).

"Each year in the United States, there are no more than 300 cases," Chen said. "All pediatric diseases are rare; luckily, this is even more rare. But we cannot count numbers in this way, because for kids that have this disease and their families, it is devastating."

Chen's technique combines Focused UltraSound with IntraNasal delivery, (FUSIN). The intranasal delivery takes advantage of a unique property of the olfactory and trigeminal nerves: they can carry nanoparticles directly to the brain, bypassing the blood brain barrier, an obstacle to drug delivery in the brain.

This unique capability of intranasal delivery was demonstrated last year by co-authors Ramesh Raliya, research scientist, and Pratim Biswas, assistant vice chancellor and chair of the Department of Energy, Environmental & Chemical Engineering and the Lucy & Stanley Lopata Professor, in their 2017 publication in Scientific Reports.

"At the beginning, I couldn't even believe this could work," Hong said of delivering drugs to the brain intranasally. "I thought our brains are fully protected. But these nerves actually directly connect with the brain and provide direct access to the brain."

While nasal brain drug delivery is a huge step forward, it isn't yet possible to target a drug to a specific area. Chen's targeted ultrasound technique is addressing that problem.

When doing an ultrasound scan, the contrast agent used to highlight images is composed of microbubbles. Once injected into the bloodstream, the microbubbles behave like red blood cells, traversing the body as the heart pumps.

Once they reach the site where the ultrasound wave is focused, they do something unusual.

"They start to expand and contract," Chen said. As they do so, they act as a

pump to the surrounding blood vessels as well as the perivascular space -- the space surrounding the blood vessels.

"Consider the blood vessels like a river," Chen said. "The conventional way to deliver drugs is to dump them in the river." In other parts of the body, the banks of the river are a bit "leaky," Chen said, allowing the drugs to seep into the surrounding tissue. But the blood brain barrier, which forms a protective layer around blood vessels in the brain, prevents this leakage, particularly in the brains of young patients, such as those with with DIPG.

"We will deliver the drug from the nose to directly outside the river," Chen said, "in the perivascular space."

Then, once ultrasound is applied at the brain stem, the microbubbles will begin to expand and contract. The oscillating microbubbles push and pull, pumping the drug toward the brainstem. This technique also addresses the problem of drug toxicity -- the drugs will go directly to the brain instead of circulating through the whole body. In collaboration with Yongjian Liu, an associate professor of radiology, and Yuan-Chuan Tai, an associate professor of radiology, Chen used positron emission tomography (PET scan) to verify that there was minimal accumulation of intranasal-administered nanoparticles in major organs, including lungs, liver, spleen, kidney and heart.

So far, Chen's lab has had success using their technique in mice for the delivery of gold nanoclusters made by the team led by Liu.

"The next step is to demonstrate the therapeutic efficacy of FUSIN in the delivery of chemotherapy drugs for the treatment of DIPG," said Dezhuang Ye, lead author of the paper, who is Chen's graduate student from the Department of Mechanical Engineering & Materials Science. The lab has also teamed up with Biswas to develop a new aerosol nasal delivery device to scale up the technique from a mouse to a large animal model.

Chen's lab collaborated on this research with pediatric neuro-oncologist Joshua Rubin, MD, PhD, a professor of pediatrics at the School of Medicine who treats patients at St. Louis Children's Hospital. Chen said the team hopes to translate the findings of this study into clinical trials for children with DIPG.

There are difficulties ahead, but Chen believes researchers will need to continue to innovate when it comes to solving such a difficult problem as treating DIPG.

A targeted inspiration

Hong Chen's lab collaborated with Joshua Rubin, MD, PhD, a professor of pediatrics at the School of Medicine on this research. And it all started with a couple of colleagues talking one day:

"My work in this field started with a conversation with him," Chen said. "He said, 'Wow, this would be a perfect technique for treating this deadly disease.' Without him to point me in this direction, I probably wouldn't have known this application existed.

"That's why I consider the Washington University environment, and the School of Engineering & Applied Science, so unique. It provides you so much opportunity to work with people from different backgrounds. It allowed me to expand my research scope and to be able to work on clinically relevant questions."

Antioxidant reduces risk for second heart attack, stroke: Cells and platelets stick inside arteries, increase risk after initial attack -- ScienceDaily

Doctors have long known that in the months after a heart attack or stroke, patients are more likely to have another attack or stroke. Now, a paper in the *Journal of the American College of Cardiology* explains what happens inside blood vessels to increase risk -- and suggests a new way to treat it.

Heart attacks in mice caused inflammatory cells and platelets to more easily stick to the inner lining of arteries throughout the body -- and particularly where there was already plaque, according to the paper. As a result, these sticky cells and platelets caused plaque to become unstable and contribute to blood clots that led to another heart attack or stroke.

But the study found treating mice that had experienced a heart attack or stroke with the powerful antioxidant apocynin cut plaque buildup in half and lowered inflammation to pre-attack levels.

"Knowing that newer forms of antioxidants such as apocynin can lower the risk of a second heart attack or stroke gives us a new treatment to explore and could one day help reduce heart attacks and strokes," said the paper's corresponding author, Jonathan R. Lindner, M.D., a professor of cardiovascular medicine at the OHSU School of Medicine.

Lindner penned the research paper with colleagues from OHSU, Scripps Research Institute and Bloodworks NW.

The researchers discovered the sticky cells and platelets by using unique forms of ultrasound imaging they developed to view molecules on the lining of blood vessels.

This research could help explain why the recent Canakinumab Anti-inflammatory Thrombosis Outcomes Study, also known as the CANTOS clinical trial, found an anti-inflammatory drug already approved to treat juvenile arthritis also reduced the risk of a second heart attack in trial participants by 15 percent.

Lindner and his colleagues are further studying how the relative stickiness of remote arteries affects the risks for additional heart attacks and strokes and are also evaluating new therapies beyond antioxidants.

The study was supported by the National Institutes of Health (R01-HL078610, R01-HL130046, R01-HL091153, R01-HL11763, HL42846, HL78784), NASA (grant 14-14NSBRI1-0025) and the Swiss National Science Foundation.

Story Source:

Materials provided by **Oregon Health & Science University**. *Note: Content may be edited for style and length.*

Hormone therapy can make prostate cancer worse, study finds -- ScienceDaily

Scientists at Cedars-Sinai have discovered how prostate cancer can sometimes withstand and outwit a standard hormone therapy, causing the cancer to spread. Their findings also point to a simple blood test that may help doctors predict when this type of hormone therapy resistance will occur.

Prostate cancer is the second-leading cause of cancer death in men, behind lung cancer, killing nearly 30,000 in the U.S. each year, according to the American Cancer Society. In its early stages, the most common type, adenocarcinoma, is curable and generally responds well to therapies, including those that target androgen -- a male sex hormone that stimulates tumor growth.

However, in certain patients, the cancer becomes resistant to androgen-targeted therapy, and the cancer recurs or spreads. One possible reason for that resistance, the study indicated, appears to be that the therapy causes some adenocarcinoma cells to become neuroendocrine cancer-type cells -- a rare type that normally appears in fewer than 1 percent of prostate cancer patients.

"This transformation is a problem because neuroendocrine prostate cancer is especially aggressive, metastasizes more readily and is more resistant to both androgen-targeted therapy and chemotherapy," said Neil Bhowmick, PhD, co-director of the Cancer Biology Program at the Samuel Oschin Comprehensive Cancer Institute at Cedars-Sinai. He is senior author of the study, published in the *Journal of Clinical Investigation*, and Rajeev Mishra, PhD, former project scientist in his laboratory, is the lead author.

Bhowmick said about one-fourth of the patients who receive androgen-targeted therapy may relapse with tumors that show features of neuroendocrine prostate cancer and develop treatment-resistant disease, according to published research.

To learn more about this process, the investigators examined how cancer cells interact with the supporting cells near the tumor, referred to as the tumor microenvironment, in laboratory mice. They found these interactions raised the level of the amino acid glutamine, turning the supporting cells into "factories" that supplied fuel for the cancer cells.

"While glutamine is known to spur cancer growth, its role in prostate cancer cells to trigger reprogramming of adenocarcinoma cells into neuroendocrine cancer cells is a new and important finding," said Roberta Gottlieb, MD, professor of Medicine and vice chair of translational medicine in the Department of Biomedical Sciences at Cedars-Sinai. Gottlieb was a co-author of the study.

The team also examined how androgen-targeted therapy affected the cancer microenvironment.

"To our surprise, we found this type of therapy further changed the cellular environment in a way that caused adenocarcinoma cells in the prostate to transform into neuroendocrine cancer-type cells," said Bhowmick, professor of Medicine and Biomedical Sciences.

As the final step in validating the findings in mice, investigators compared levels of glutamine in the plasma of small groups of patients -- one with treatment-responsive prostate cancer and the other with treatment-resistant prostate cancer. They found that levels of glutamine were higher in the second group.

This finding has potential implications for treating prostate cancer patients, said Edwin Posadas, MD, co-director of the Translational Oncology Program at the cancer institute and associate professor and clinical chief of the Division of Hematology/Oncology in the Department of Medicine at Cedars-Sinai.

"The study raises the possibility that a simple blood test measuring glutamine might be able to pinpoint when androgen-targeted therapy is failing in a prostate cancer patient and even predict when therapy resistance will occur," said Posadas, who co-authored the study. He said the team is designing a new study to test this hypothesis.

Funding: Research reported in this publication was supported by the National Cancer Institute of the National Institutes of Health under award numbers CA 108646 and CA 098912 and the U.S. Department of Veterans Affairs under award number BX001040.

High precision microbial population dynamics under cycles of feast and famine: Automated sampling and measuring provides around-the-clock data collection -- ScienceDaily

Scientists at the University of Illinois at Urbana-Champaign have produced the most precise picture to date of population dynamics in fluctuating feast-or-famine conditions. Professor Seppe Kuehn, a biological physicist, and his graduate student Jason Merritt found that bacterial population density is a function of both the frequency and the amplitude of nutrient fluctuations. They found that the more frequent the feast cycles and the longer a feast cycle, the more rapid the population recovery from a famine state. This result has important implications for understanding how microbial populations cope with the constant nutrient fluctuations they experience in nature.

The team's findings were made possible by extraordinarily precise measurements of population dynamics in bacterial communities. The measurement, based on automated imaging of hundreds of millions of single cells, allowed the team to capture population dynamics over periods of more than a week with a temporal resolution of one minute. Those numbers and the extended duration of the experiment couldn't have happened without Merritt's continuous-culture systems, coupled to automated-sampling fluorescence microscopes.

These findings are published in the August 28 issue of *Physical Review Letters*.

The experimental setup took about two years and many prototypes to develop. Merritt built six identical systems for the experiment, each one automated to continuously pump in fresh media and pump out bacterial cultures for sampling. The samples were continuously imaged to track

changes in population density and structure. Software developed by Merritt automatically segments images to count bacterial cells, producing massive data sets. The software takes advantage of machine learning to resolve otherwise difficult-to-solve problems in image recognition and processing.

Kuehn comments, "Scientists studying populations of bacteria typically take samples manually and do their counting offline, in person. What Jason's systems do is automatically remove a sample, pass it in front of a microscope to be imaged, and then put it back. And they do that once a minute, 24 hours a day, with no input, for up to a month. His software counts the cells in the images, extracting information in real time."

He continues, "So that's a big step forward -- this has never been achieved before. Short-timescale quantitative studies have been done using microfluidic devices, but these are limited to about three days' runtime. We can run for 30 days, producing long-timescale highly quantitative measurements. We can easily run replicate experiments, reproducing the same results. Because of this, we were able to use the system to test hypotheses about the underlying mechanisms governing the dynamics we observed."

Merritt comments, "The idea for the system grew out of previous work Seppe had done. The device I built is basically a metal block with glass vials within it. The most important part of our system and the part that was the most difficult to get to work reliably is the coupling to a fluorescence microscope."

The system continuously draws samples out of the liquid culture into flexible tubing and then into a thin glass capillary in the path of the microscope. The bacteria pass through the capillary many at a time, but are spaced apart from one another. The biggest challenge overall was on the software side, doing proper image segmentation to convert the images to data.

The main finding, that populations apparently recovery faster from more frequent or larger pulses of nutrients, puzzled the team at first. However, the precision of the measurement allowed them to uncover the mechanism.

Merritt continues, "What we found out is that the fast recovery rates for the planktonic population are driven by dispersal from aggregated cells

(biofilms) during feast conditions. So basically when there's a lot of food, these cell aggregates start shedding cells rapidly, and the cells that shed off start growing rapidly. But during famine conditions when there's not very much food, these cells start coming back together and forming the aggregates again. This is the mechanism driving the frequency and amplitude dependence."

Kuehn adds, "Variations in a natural population may be the result of any one or a combination of many different variables -- the amount of nutrients, temperature, competition and predation, etc. -- so it's difficult to measure cause and effect. In the lab, we tightly control all of the parameters of our experiment. And now we can make a really robust and reproducible quantitative measurement. Going forward, we would like to modify these systems to study topics in evolutionary history. We also plan to do studies in which we use feedback control of microbial communities, to see whether we can push the communities back into a particular state. These are studies that wouldn't be possible without an automated system like the one we used in this study."

California: Global warming, El Niño could cause wetter winters, drier conditions in other months: Warming ocean temperatures will intensify winter rainfall in California -- ScienceDaily

So here's the good news: Despite fears to the contrary, California isn't facing a year-round drought in our warming new world.

However, UC Riverside Earth Sciences Professor Robert Allen's research indicates that what precipitation the state does get will be pretty much limited to the winter months -- think deluge-type rainfall rather than snow -- and non-winter months will be even dryer than usual, with little or no rain at all.

"It is good news," Allen said. "But only relative to the alternative of no rain at all."

Allen's latest findings build on his 2017 research that concluded global warming will bring increased winter precipitation to California through the end of this century.

The findings are outlined in a paper by Allen and his co-author Ray Anderson, research soil scientist at the USDA-ARS US Salinity Lab, titled "21st century California drought risk linked to model fidelity of the El Niño teleconnection." It was published September 3 in *Climate and Atmospheric Science*.

The paper focuses on how "greenhouse-gas-induced climate change" will affect drought conditions in the state. The findings are based on 40 climate models that were compared to actual precipitation, soil moisture, and streamflow in the state between 1950 and 2000.

Historically, about 90 percent of California's rain and snow have come during the winter months of December, January, and February, Allen said, with sporadic rain scattered over the rest of the year. But now, warming surface temperatures in the tropical Pacific Ocean are expected to amplify the rainy season by sending stormy El Niño conditions over the state in the winter.

Bottom line, Allen said, the flooding and mudslides that accompanied the heavy winter rains of 2017 shouldn't be considered an aberration, but potentially California's new weather norm.

The trick will be finding a way to capture excess water for dry periods, he said. "It's all about smoothing the seasonable differences. If we can take advantage of the enhanced winter rainfall, we can hopefully get through the drying trends the rest of the year."

Trapping that winter precipitation will be a challenge, however, especially since it's likely to come more in the form of rain than snow due to the warming climate. Historically, snow in the mountains feeds reservoirs and provides water to agriculture when it is needed in the summer, but rain will just run off unless it is captured.

Allen's findings also bode ill for California's fire season. The state's new norm could mimic -- or surpass -- the fire season of 2017, the worst in California's history, as wet winters encourage lush spring growth that will quickly parch during the hot and dry season, becoming wildfire fuel.

In fact, Allen said, these "new norm" projections aren't for a distant future.

"I think it's here now, so we need to start acting as quickly as possible," he said. "Adaptation is incredibly important in response to climate change, and in this case it means enhancing our water storage capabilities, our reservoirs and dam structures, because things are going to become drier in the nonwinter months."

And for ordinary citizens? This might be a great time to start investing in rain barrels.

"In Southern California, it could mean having native plants in your yard

because a grass yard has to be irrigated, and that's probably not the wisest use of water," he said. "It's all about living sustainably."

Giving tortoises a 'head start': Raising gopher tortoises in captivity may boost wild populations -- ScienceDaily

Research from the University of Georgia indicates that head-starting -- raising a species in captivity and releasing it into a protected habitat after it has grown large enough to be less vulnerable to predators -- is a useful intervention for boosting the state's gopher tortoise population, which has been declining in numbers for decades due to predation, poaching and loss of suitable habitat.

Seventy percent of head-started tortoises raised from donor eggs were still alive a year after release at Yuchi Wildlife Management Area in Burke County, according to research by Tracey Tuberville and Dan Quinn. They published their findings in the *Journal of Wildlife Management*.

The gopher tortoise, Georgia's state reptile, is a keystone species whose burrows provide shelter for more than 250 other species, said Tuberville, associate research scientist at the Savannah River Ecology Laboratory and adjunct faculty at the Warnell School of Forestry and Natural Resources.

Despite predation risks at the release site, survival rates were higher than survival reported for their wild counterparts, according to Quinn, a graduate student at SREL and Warnell during the research.

Quinn conducted two soft-releases of yearlings at YWMA during consecutive years. The team said the second release was the largest tortoise release in the state to date.

"We initially released the tortoises into pens to acclimate them into the natural environment," he said. "This gives them time to construct a burrow and in theory it reduces predation risk."

Forty-two of 145 yearlings were radio tracked and monitored for a year following the soft releases, providing information to inform future head-starting efforts.

Tracking data revealed that the juveniles demonstrated a strong rate of site fidelity, remaining together in a protected area, which allows them to reproduce. This means the soft-release technique is not necessary, according to Tuberville.

Instead, the researchers will implement multiple releases in various locations to help reduce predation risk. Predators included fire ants, raccoons and dogs, with fire ants accounting for the majority of fatalities.

Head-starting efforts at YWMA will continue with tortoises that are 2 to 3 years old, an age when they are less susceptible to predators, Tuberville said. Additional research will evaluate whether the positive effect on post-release survival warrants the additional time in captivity.

Story Source:

Materials provided by **University of Georgia**. *Note: Content may be edited for style and length.*

Parsing natural climate variability from human-caused climate change -- ScienceDaily

A new study says pink noise may be the key to separating out natural climate variability from climate change that is influenced by human activity.

Not familiar with pink noise? It's a random noise in which every octave contains the same amount of energy. Pink noise is found in systems ranging from earthquakes and electronics to biology and stellar luminosity. Compared to the more familiar white noise, pink noise has more low-frequency components.

Writing in the journal *Physical Review Letters*, Yale researcher John Wettlaufer, graduate student Sahil Agarwal, and first author and Yale graduate Woosok Moon of Stockholm University found that pink noise energy signatures on decadal time scales appear in historical climate proxy data both before and after the Industrial Revolution.

"A central question in contemporary climate science concerns the relative roles of natural climate variability and anthropogenic forcing -- climate change related to human involvement -- which interact in a highly nonlinear manner on multiple timescales, many of which transcend a typical human lifetime," said Wettlaufer, the A.M. Bateman Professor of Geophysics, Mathematics and Physics at Yale.

"We find that the observed pink noise behavior is intrinsic to Earth's climate dynamics, which suggests a range of possible implications, perhaps the most important of which are 'resonances' in which processes couple and amplify warming," Wettlaufer said.

Story Source:

Materials provided by **Yale University**. *Note: Content may be edited for style and length.*

Ultracold atoms used to verify 1963 prediction about 1D electrons: Theory is increasingly relevant to chipmakers -- ScienceDaily

Rice University atomic physicists have verified a key prediction from a 55-year-old theory about one-dimensional electronics that is increasingly relevant thanks to Silicon Valley's inexorable quest for miniaturization.

"Chipmakers have been shrinking feature sizes on microchips for decades, and device physicists are now exploring the use of nanowires and nanotubes where the channels that electrons pass through are almost one-dimensional," said Rice experimental physicist Randy Hulet. "That's important because 1D is a different ballgame in terms of electron conductance. You need a new model, a new way of representing reality, to make sense of it."

With IBM and others committed to incorporating one-dimensional carbon nanotubes into integrated circuits, chip designs will increasingly need to account for 1D effects that arise from electrons being fermions, antisocial particles that are unwilling to share space.

The 1D implications of this standoffishness caught the attention of physicists Sin-Itiro Tomonaga and J.M. Luttinger, whose model of 1D electron behavior was published in 1963. A key prediction of Tomonaga-Luttinger liquid (TLL) theory is that exciting one electron in a 1D wire leads to a collective, organized response from every electron in the wire.

Stranger still, because of this collective behavior, TLL theory predicts that a moving electron in 1D will seemingly split in two and travel at different speeds, despite the fact that electrons are fundamental particles that have no constituent parts. This strange breakup, known as spin-charge separation, instead involves two inherent properties of the electron -- negative charge and

angular momentum, or "spin."

In a study online this week in *Physical Review Letters*, Hulet, University of Geneva theoretical physicist Thierry Giamarchi and their colleagues used another type of fermion -- ultracold lithium atoms cooled to within 100 billionths of a degree of absolute zero -- to both verify the predicted speed that charge waves move in 1D and offer confirmation that 1D charge waves increase their speed in proportion to the strength of the interaction between them.

"In a one-dimensional wire, electrons can move to the left or to the right, but they cannot go around other electrons," said Hulet, Rice's Fayez Sarofim Professor of Physics. "If you add energy to the system, they move, but because they're fermions and can't share space, that movement, or excitation, causes a kind of chain reaction.

"One electron moves, and it nudges the next one to move and the one next to that one and so on, causing the energy you've added to move down the wire like a wave," Hulet said. "That single excitation has created a ripple everywhere in the wire."

In their experiments, Hulet's team used lithium atoms as stand-ins for electrons. The atoms are trapped and slowed with lasers that oppose their motion. The slower they go, the colder the lithium atoms become, and at temperatures far colder than any in nature, the atoms behave like electrons. More lasers are used to form optical waveguides, one-dimensional tubes wide enough for just one atom. Despite the effort needed to create these conditions, Hulet said the experiments offer a big advantage.

"We can use a magnetic field in our experiment to tune the strength of the repulsive interaction between the lithium atoms," Hulet said. "In studying these collective, or correlated electron behaviors, interaction strength is an important factor. Stronger or weaker electron interactions can produce wholly different effects, but it's extraordinarily difficult to study this with electrons because of the inability to directly control interactions. With ultracold atoms, we can essentially dial the interaction strength to any level we want and watch what happens."

While previous groups have measured the speed of collective waves in nanowires and in gases of ultracold atoms, none had measured it as a function of interaction strength, Hulet said.

"Charge excitations are predicted to move faster with increasing interaction strength, and we showed that," he said. "Thierry Giamarchi, who literally wrote the book on this topic, used TLL theory to predict how the charge wave would behave in our ultracold atoms, and his predictions were borne out in our experiments."

Having that ability to control interactions also sets the stage for testing the next TLL prediction: The speed of charge waves and spin waves diverge with increasing interaction strength, meaning that as electrons are made to repel one another with greater force, charge waves will travel faster and spin waves will travel slower.

Now that the team has verified the predicted behavior of charge waves, Hulet said they next plan to measure spin waves to see if they behave as predicted.

"The 1D system is a paradigm for strongly correlated electron physics, which plays a key role in many things we'd like to better understand, like high-temperature superconductivity, heavy fermion materials and more," Hulet said.

Why we stick to false beliefs: Feedback trumps hard evidence: New study finds that feedback rather than hard evidence makes us more confident that we're right -- ScienceDaily

Ever wonder why flat earthers, birthers, climate change and Holocaust deniers stick to their beliefs in the face of overwhelming evidence to the contrary?

New findings from researchers at the University of California, Berkeley, suggest that feedback, rather than hard evidence, boosts people's sense of certainty when learning new things or trying to tell right from wrong.

Developmental psychologists have found that people's beliefs are more likely to be reinforced by the positive or negative reactions they receive in response to an opinion, task or interaction, than by logic, reasoning and scientific data.

Their findings, published today in the online issue of the journal *Open Mind*, shed new light on how people handle information that challenges their worldview, and how certain learning habits can limit one's intellectual horizons.

"If you think you know a lot about something, even though you don't, you're less likely to be curious enough to explore the topic further, and will fail to learn how little you know," said study lead author Louis Marti, a Ph.D. student in psychology at UC Berkeley.

This cognitive dynamic can play out in all walks of actual and virtual life, including social media and cable-news echo chambers, and may explain why some people are easily duped by charlatans.

"If you use a crazy theory to make a correct prediction a couple of times, you can get stuck in that belief and may not be as interested in gathering more information," said study senior author Celeste Kidd, an assistant professor of psychology at UC Berkeley.

Specifically, the study examined what influences people's certainty while learning. It found that study participants' confidence was based on their most recent performance rather than long-term cumulative results. The experiments were conducted at the University of Rochester.

For the study, more than 500 adults, recruited online through Amazon's Mechanical Turk crowdsourcing platform, looked at different combinations of colored shapes on their computer screens. They were asked to identify which colored shapes qualified as a "Daxxy," a make-believe object invented by the researchers for the purpose of the experiment.

With no clues about the defining characteristics of a Daxxy, study participants had to guess blindly which items constituted a Daxxy as they viewed 24 different colored shapes and received feedback on whether they had guessed right or wrong. After each guess, they reported on whether or not they were certain of their answer.

The final results showed that participants consistently based their certainty on whether they had correctly identified a Daxxy during the last four or five guesses instead of all the information they had gathered throughout.

"What we found interesting is that they could get the first 19 guesses in a row wrong, but if they got the last five right, they felt very confident," Marti said. "It's not that they weren't paying attention, they were learning what a Daxxy was, but they weren't using most of what they learned to inform their certainty."

An ideal learner's certainty would be based on the observations amassed over time as well as the feedback, Marti said.

"If your goal is to arrive at the truth, the strategy of using your most recent feedback, rather than all of the data you've accumulated, is not a great tactic," he said.

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Superbug discovery renews hope for antibiotic treatment -- ScienceDaily

Bacteria that were thought to be resistant to a powerful antibiotic may be susceptible to treatment after all, research has found.

The food-poisoning bug Listeria was shown to respond to an antibiotic even though the bacteria carry genes that should make it highly resistant.

Scientists say the antibiotic -- called fosfomycin -- should be reconsidered as a treatment for life-threatening Listeria infections.

Early lab tests had indicated that fosfomycin fails to kill Listeria because the bacteria carry a gene that enables it to break down the drug.

Further studies, however, found that the drug was effective at killing Listeria in infected cells in the lab and in mice.

Genes that are only activated when the bacteria infect the body cancel out the effects of the drug-destroying gene, researchers at the University of Edinburgh found.

The findings suggest fosfomycin could prove to be a useful treatment for life-threatening Listeria cases despite these bacteria testing resistant based on laboratory tests, the researchers say.

Listeria infection -- also known as listeriosis -- is the most lethal food-borne disease known and is often fatal. It is caused by eating contaminated foods such as soft cheeses, smoked salmon, pates, meats and salads.

The infection is particularly deadly for those with weak immune systems, such as older people and newborns. It can also cause miscarriage.

These bacteria reproduce within the cells of the body and frequently affect the brain, which only certain medicines are able to treat. This limits the

treatment options for serious infections, and so fosfomycin may prove highly beneficial.

The study, published in the journal *PLOS Genetics*, was funded by Wellcome.

Professor Jose Vazquez-Boland, who led the research at the University of Edinburgh's Division of Infection Medicine, said: "Our study focused on Listeria, but this important discovery may be relevant for other species of bacteria too. It is encouraging that we may be able to repurpose existing drugs in the race against antibiotic resistance."

Story Source:

Materials provided by **University of Edinburgh**. *Note: Content may be edited for style and length.*

Dementia symptoms peak in winter and spring, study finds -- ScienceDaily

Adults both with and without Alzheimer's disease have better cognition skills in the late summer and early fall than in the winter and spring, according to a new study published this week in *PLOS Medicine* by Andrew Lim of Sunnybrook Health Sciences Centre and the University of Toronto, Canada, and colleagues.

There have been few previous studies concerning the association between season and cognition in older adults. In the new work, researchers analyzed data on 3,353 people enrolled in three different cohort studies in the U.S., Canada, and France. Participants had undergone neuropsychological testing and, for some participants, levels of proteins and genes associated with Alzheimer's disease were available.

The authors found that average cognitive functioning was higher in the summer and fall than the winter and spring, equivalent in cognitive effect to 4.8 years difference in age-related decline. In addition, the odds of meeting the diagnostic criteria for mild cognitive impairment or dementia were higher in the winter and spring (odds ratio 1.31, 95% CI: 1.10-1.57) than summer or fall. The association between season and cognitive function remained significant even when the data was controlled for potential confounders, including depression, sleep, physical activity, and thyroid status. Finally, an association with seasonality was also seen in levels of Alzheimer's-related proteins and genes in cerebrospinal fluid and the brain. However, the study was limited by the fact that each participant was only assessed once per annual cycle, and only included data on individuals from temperate northern-hemisphere regions, not from southern-hemisphere or equatorial regions.

"There may be value in increasing dementia-related clinical resources in the winter and early spring when symptoms are likely to be most pronounced," the authors say. "By shedding light on the mechanisms underlying the seasonal improvement in cognition in the summer and early fall, these

findings also open the door to new avenues of treatment for Alzheimer's disease."

Story Source:

Materials provided by **PLOS**. *Note: Content may be edited for style and length.*

Fossil teeth show how Jurassic reptiles adapted to changing seas -- ScienceDaily

Marine predators that lived in deep waters during the Jurassic Period thrived as sea levels rose, while species that dwelled in the shallows died out, research suggests.

A study of fossilised teeth has shed light on how reptiles adapted to major environmental changes more than 150 million years ago, and how sea life might respond today.

It also reveals for the first time that the broad structure of food chains beneath the sea has remained largely unchanged since the Jurassic era.

For more than 18 million years, diverse reptile species lived together in tropical waters that stretched from present-day northern France to Yorkshire in the north of England.

Until now, however, little was known about the structure of the food chain in this region -- called the Jurassic Sub-Boreal Seaway -- or how it changed as sea levels rose.

By analysing the shape and size of teeth spanning this 18-million-year period when water levels fluctuated, palaeontologists at the University of Edinburgh found that species belonged to one of five groups based on their teeth, diet and which part of the ocean they inhabited.

The pattern is very similar to the food chain structure of modern oceans, where many different species are able to co-exist in the same area because they do not compete for the same resources, the team says.

As global sea levels rose, reptiles that lived in shallow waters and caught fish using thin, piercing teeth declined drastically, researchers found.

At the same time, larger species that inhabited deeper, open waters began to thrive. These reptiles had broader teeth for crunching and cutting prey.

Deep-water species may have flourished as a result of major changes in ocean temperature and chemical make-up that also took place during the period, the team says. This could have increased levels of nutrients and prey in deep waters, benefitting species that lived there.

The study offers insights into how species at the top of marine food chains today might respond to rapid environmental changes -- including climate change, pollution and rising temperatures.

The study, which also involved the University of Bristol, is published in the journal *Nature Ecology & Evolution*. It was supported by the Leverhulme Trust, Marie Sk?odowska-Curie Actions, Systematics Research Fund, Palaeontographical Society and Palaeontological Association.

Davide Foffa, of the University of Edinburgh's School of GeoSciences, who led the study, said: "Studying the evolution of these animals was a real -- and rare -- treat, and has offered a simple yet powerful explanation for why some species declined as others prospered. This work reminds us of the relevance of palaeontology by revealing the parallels between past and present-day ocean ecosystems."

Dr Steve Brusatte, also of the University's School of GeoSciences, said: "Teeth are humble fossils, but they reveal a grand story of how sea reptiles evolved over millions of years as their environments changed. Changes in these Jurassic reptiles parallel changes in dolphins and other marine species that are occurring today as sea-levels rise, which speaks to how important fossils are for understanding our modern world."

Story Source:

Materials provided by **University of Edinburgh**. *Note: Content may be edited for style and length.*

New smart materials could open new research field: Serendipitous discovery could increase efficiency in jet engines, reduce plane noise, more -- ScienceDaily

A group of new smart materials discovered by researchers at Texas A&M University and their colleagues has the potential to significantly improve the efficiency of fuel burn in jet engines, cutting the cost of flying. The materials, which could also reduce airplane noise over residential areas, have additional applications in a variety of other industries.

"What excites me is that we have just scratched the surface of something new that could not only open a completely new field of scientific research, but also enable new technologies," said Dr. Ibrahim Karaman, Chevron Professor I and head of the university's Department of Materials Science and Engineering.

The work was published in *Scripta Materialia*. Karaman's co-authors are Demircan Canadinc, William Trehern, and Ji Ma of Texas A&M, and Fanping Sun and Zaffir Chaudhry, Technical Fellow of the United Technologies Research Center (UTRC).

The discovery is based on bringing together two relatively new areas of materials science involving metal alloys, or metals composed of two or more elements. The first area involves shape-memory alloys, "smart" materials that can switch from one shape to another with specific triggers, in this case temperature. Picture a straight metal rod that is bent into a corkscrew. By changing the temperature, the corkscrew turns back into a rod and vice versa.

Many applications

Many potential applications for shape-memory alloys involve extremely hot environments like a working jet engine. Until now, however, economical

high-temperature shape memory alloys, (HTSMAs), have only worked at temperatures up to about 400 degrees Celsius. Adding elements like gold or platinum can significantly increase that temperature, but the resulting materials are much too expensive, among other limitations.

Karaman, while working on a NASA project with UTRC and colleagues, began this research to address a specific problem: controlling the clearance, or space, between turbine blades and the turbine case in a jet engine. A jet engine is most fuel-efficient when the gap between the turbine blades and the case is minimized. However, this clearance has to have a fair margin to deal with peculiar operating conditions. HTSMAs incorporated into the turbine case could allow the maintenance of the minimum clearance across all flight regimes, thereby improving thrust specific fuel consumption.

Another important potential application of HTSMAs is the reduction of noise from airplanes as they come in to an airport. Planes with larger exhaust nozzles are quieter, but less efficient in the air. HTSMAs could automatically change the size of the core exhaust nozzle depending on whether the plane is in flight or is landing. Such a change, triggered by the temperatures associated with these modes of operation, could allow both more efficient operation while in the air and quieter conditions at touchdown.

Karaman and his colleagues decided to try increasing the operating temperatures of HTSMAs by applying principles from another new class of materials, high-entropy alloys, which are composed of four or more elements mixed together in roughly equal amounts. The team created materials composed of four or more elements known to form shape-memory alloys (nickel, titanium, hafnium, zirconium and palladium), but purposefully omitted gold or platinum.

"When we mixed these elements in equal proportions we found that the resulting materials could work at temperatures well over 500 degrees C -- one worked at 700 degrees C -- without gold or platinum. That's a discovery," said Karaman. "It was also unexpected because the literature suggested otherwise."

How do the new materials work? Karaman said they have ideas on how they operate at such high temperatures, but do not have solid theories yet. To that

end, future work includes trying to understand what is happening at the atomic scale by conducting computer simulations. The researchers also aim to explore ways to improve the materials' properties even further. Karaman notes, however, that many other questions remain.

"That's why I believe this could open a completely new area of research," he said. "While we will continue our own efforts, we are excited that others will now join us so that together we can push the boundaries of science."

This joint project between UTRC and Texas A&M was funded by the NASA Leading Edge Aeronautics Research initiative.

Story Source:

Materials provided by **Texas A&M University**. Original written by Elizabeth Thomson. *Note: Content may be edited for style and length.*

State-of-the-art imaging techniques reveal heightened detail and beauty of vertebrate life -- ScienceDaily

A mingling of science and art, the next-generation photographs of vertebrate skeletons are at once fascinating, eerie, intricate and exquisite.

"People are inherently interested in how these skeletons look," said W. Leo Smith, associate professor of ecology and evolutionary biology and associate curator at the University of Kansas Biodiversity Institute & Natural History Museum. "In any given scholarly paper, you'd be lucky to have a couple of hundred people read it top to bottom -- but a lot more people will look at the images. The more we can improve that, the more people you can get interested in your research."

Since the 1800s, biologists and paleontologists have taken pictures of specimens to perform comparative anatomical studies. Now, techniques pioneered by Smith and a team of researchers headquartered at KU are giving scientists around the world fresh methods to capture images of vertebrates -- a breakthrough enabling better, more useful digital pictures of Earth's biodiversity.

The team describes the two novel imaging procedures in a new paper appearing in the peer-reviewed journal *Copeia*.

One new process involves "cleared and stained" specimens, which have been stripped of their muscles in a time-honored technique using cow enzymes. The team discovered how to position such specimens within a glycerine-gelatin mixture for otherwise impossible images.

"The problem we had was we couldn't pose these animals because we've digested away all of the muscles," Smith said. "They're flaccid and useless, like a pile of clothes that fold in every direction. We wanted the ability to

pose them."

The researchers hunted for the best ratio of glycerine and gelatin that allowed specimens to be posed in a nondestructive medium that could be simply washed off after photography. Much of the "nitty gritty" work was performed by doctoral student Matthew Girard and intern Chesney A. Buck, an aspiring taxidermist interning with Smith's group from Van Go Inc., an arts-based employment program for at-risk teens and young adults.

"She was interested in artistic taxidermy, mixing animal parts like have been done with the jackalope," Smith said. "She knew about clearing and staining and wanted to know how to do it. After her internship, she volunteered for a year more. There was a lot of trial and error. We tried lots of different things."

Other co-authors on the new paper are Gregory S. Ornay, Rene P. Martin and Girard of KU's Biodiversity Institute, along with Matthew P. Davis and Sarah Z. Gibson of St. Cloud State University.

Eventually, the team found a 40 percent glycerine mixture that held specimens well and was sufficiently translucent for photography, allowing them new looks at specimens that could "float" within the matrix.

"You can see through this medium and give the specimen structure," Smith said. "Now you can get a photo of a fish specimen head on and look at it from all these different angles. There's something different about being able to see anatomical structure in new ways that really does help analysis. Before, we struggled with how to pose these things. For instance, fish are famous for having two sets of jaws, an oral set like ours and then another set of teeth where our voice box is -- you couldn't get a photo of these teeth head-on before now."

Smith said the new technique could be used on a host of vertebrate species beyond the fishes he studies.

"It'd be great to pose a snake coiled, but before now they just wouldn't hold in that pose. Or if you were trying to get an image of some structure obscured by the wing of a bird and couldn't get it out of the way, we've often had to cut

the wing off, but now you could deflect the wing to show that structure."

A second method developed by the group employs fluorescent microscopy to examine specimens and create captivating images of alizarin-stained recent and fossil vertebrates. The work hinges on the fact that alizarin, a stain long used in the clearing and staining process to identify bones in a specimen, fluoresces when exposed to the right wavelengths of light -- a phenomenon Smith discovered himself. (Another team independently discovered the phenomenon in a paper about zebrafish.)

"Alizarin red is used to dye a specimen's bones, and it fluoresces like a Grateful Dead poster," Smith said. "We use lights that have high energy and look for reflections of re-emitted fluorescent wavelength, and the microscope has filters that block all the other light. The skin and everything else disappears because it doesn't fluoresce -- it's a fast way to clear out all the extra stuff and is incredibly useful when you're trying to see where bones are connected. It was pure luck to find this."

The KU researcher reported the fluorescence microscopy finding to colleagues last year at the annual meeting of the American Society of Ichthyologists and Herpetologists, and today other investigators in the field already are using the matrix in their own digital imaging work thanks to the presentation.

"Now lots of people are doing it," Smith said. "It's been really rewarding. You feel like you contributed something to make this kind of research more interesting and allow us to study anatomy better."

While Smith doesn't consider the how-to descriptions of new imaging techniques to be of equal weight as the scientific papers he regularly produces, he stressed the importance of providing compelling images to conveying information to fellow investigators and the public alike.

"At end of the day, the picture is worth a thousand words," he said. "Images allow you to fundamentally share how things work and improve your ability to tell someone else about your novel discoveries."

https://www.sciencedaily.com/releases/2018/09/180904140605.htm

What could have extended human lifespan? Researchers identify 25 genetic changes -- ScienceDaily

Senescence, or biological aging, refers to the general deterioration of an organism's physiological functions, leading to increased susceptibility to diseases and ultimately death. It is a complex process that involves many genes. Lifespans vary greatly across different animal species. Thus, for example, flies live for four weeks, horses for thirty years, whereas some hedgehogs may live for up to two centuries. Why is the range of lifespans in nature so broad? This is one of the basic and most intriguing questions faced by biologists.

Potentially, human beings can live for up to 120 years, whereas the species of some closer primates live for half that period. In order to explain the reasons behind these differences, researchers from the Institute of Evolutionary Biology (IBE), a mixed centre belonging to the Pompeu Fabra University (UPF) and the Spanish National Research Council (CSIC), in collaboration with scientists from the Centre for Genomic Regulation (CRG), the University of Bristol and the University of Liverpool, have identified some of the genes that may have been crucial in extending the life of our species, as well as that of primates with a longer lifespan. The study has been published in the *Molecular Biology & Evolution* journal and is featured on the front cover.

In this work, the researchers studied the genomes of seventeen primate species, including humans. From the standpoint of aging, primates are interesting because while they are very similar, there are major differences across the different species in terms of longevity. Hence, of all the species studied, only three ? humans and two macaques ? lived longer than the common ancestor, which proves that "they have undergone a relatively rapid process of lifespan evolution," explains Arcadi Navarro, ICREA research professor at the IBE and the study leader.

The genes of these three species were compared to those of the remaining fourteen species in order to detect the mutations present in those with a longer life. "This would constitute very suggestive evidence that these genes have helped to extend their lives," says Navarro, who is also Professor of the UPF and CRG collaborator. Following the comparison, twenty-five mutations were identified in genes associated with wound-healing, coagulation and a large number of cardiovascular conditions.

"The results are meaningful, because a flexible and adaptable control of coagulation mechanisms are required in species that live longer," explains Gerard Muntané, the study's leading author and a postdoctoral researcher at the IBE and at the Institut d'Investigació Sanitària Pere Virgili (IISPV). Moreover, adds Muntané, "they confirm the pleiotropy theory of aging," which proposes that "certain mutations may have different effects depending on life-stage: they help us in the early stages but damage us in later stages, once the reproductive stage has ended."

The authors suggest that the results could help to develop new therapeutic targets for treating aging-related diseases and to demonstrate the potential of an evolutionary approach to medicine.

Story Source:

Materials provided by **Center for Genomic Regulation**. *Note: Content may be edited for style and length.*

Peering into private life of atomic clusters -- using the world's tiniest test tubes -- ScienceDaily

Experts in the Nanoscale and Microscale Research Centre (nmRC) at the University of Nottingham have taken a first peak into the private life of atomic clusters. Here's what they can see.

Having already succeeded in 'filming' inter-molecular chemical reactions -- using the electron beam of a transmission electron microscope (TEM) as a stop-frame imaging tool -- they have now achieved time-resolved imaging of atomic-scale dynamics and chemical transformations promoted by metal nanoclusters. This has enabled them to rank 14 different metals both in order of their bonding with carbon and their catalytic activity, showing significant variation across the Periodic Table of Elements.

Their latest work, 'Comparison of atomic scale dynamics for the middle and late transition metal nanocatalysts', has been published in *Nature Communications*. Andrei Khlobystov, Professor of Nanomaterials and Director of nmRC, said: "Thanks to the recent advances in microscopy and spectroscopy we now know a great deal about the behaviour of molecules and atoms. However, the structure and dynamics of atomic-scale clusters of metallic elements remains a mystery. The complex atomic dynamics revealed directly by imaging in real time sheds light on atomistic workings of nanocatalysts."

Contribution to global GDP

The atomic-scale dynamics of metal nanoclusters determine their functional and chemical properties such as catalytic activity -- their ability to increase the rate of a chemical reaction. Many key industrial processes currently rely on nanocatalysts such as water purification; fuel cell technologies; energy storage; and bio-diesel production.

Professor Khlobystov said: "With catalytic chemical reactions contributing substantially to the global GDP, understanding the dynamic behaviour of nanoclusters at the atomic level is an important and urgent task. However, the combined challenge of non-uniform structures of nanocatalysts -- for example, distribution of sizes, shapes, crystal phases -- coexisting within the same material and their highly dynamic nature -- nanoclusters undergo extensive structural and, in some cases, chemical transformations during catalysis -- makes elucidation of the atomistic mechanisms of their behaviour virtually impossible."

From single-molecule dynamics to atomic clusters

Professor Khlobystov led the Anglo-German collaboration that harnessed the impact of the electron beam (e-beam) in the transmission electron microscopy (TEM) for imaging single-molecule dynamics. By employing the e-beam simultaneously as an imaging tool and a source of energy to drive chemical reactions they succeeded at filming reactions of molecules. The research was published last year in ACS Nano, a flagship nanoscience and nanotechnology journal, and selected as ACS Editor's Choice due to its potential for broad public interest.

Instead of laboratory flasks or test tubes, they employ the World's tiniest test tubes -- single walled carbon nanotubes -- atomically thin cylinders of carbon with internal diameters of 1-2 nm that have held a Guinness World Record since 2005.

A Periodic Table in a nano test tube

Professor Khlobystov said: "We use these carbon nanotubes to sample tiny clusters of chemical elements, each consisting of only a few dozens of atoms. By entrapping the nanoclusters of a series of related metallic elements we effectively created in a Periodic Table in a nano test tube, allowing a global comparison of chemistry of transition metals across the Periodic Table. This has always been extremely challenging because most metal nanoclusters are highly sensitive to air. The combination of the nano test tube and TEM allows us to watch not only the dynamics of metal nanoclusters but also their bonding with carbon that show a clear link with the metal's position in the Periodic Table."

Ute Kaiser, Professor in Experimental Physics and Leader of the Group of Electron Microscopy of Materials Science at Ulm University said: "Aberration-corrected transmission electron microscopy and the low-dimensional materials, such as nanotubes filled with metal nanoclusters, are an ideal match for each other because they allow an effective combination of advances in analytical and theoretical chemistry with latest developments in electron microscopy, leading to new understanding of phenomena at the atomic scale, such as nanocatalysis in this work."

Watching nanoclusters in unprecedented resolution

Kecheng Cao, PhD student at Ulm University, who carried out image analysis in this study said: "When I am looking at atoms through the microscope, sometimes I stop breathing to see the invisible details we discover for the nanoclusters on our newly developed SALVE III microscope providing unprecedented resolution."

Elena Besley, Professor of Theoretical and Computational Chemistry at the University of Nottingham said: "Reaching inside the tiniest building blocks of metals, this study demonstrated that metal nanoclusters entrapped in carbon nano test tubes provide a universal platform for studying organometallic chemistry and enable a direct comparison of the bonding and reactivity of different transition metals as well as elucidation of the structure-performance relationship for nanocatalysts -- vital for the discovery of new reaction mechanisms and more efficient catalysts of the future. This study provides a first qualitative glimpse of a global perspective of metal-carbon bonding."

This study is the latest in a series of more than 20 high-calibre joint papers on the topic of electron microscopy for molecules and nanomaterials published by the Ulm-Nottingham collaboration.

Professor Kaiser has recently been appointed an Honorary Professor at the University of Nottingham in recognition of her rich contribution to the collaboration between the two universities spanning over nearly a decade.

Novel strategy shows promise for earlier detection of Alzheimer's disease -- ScienceDaily

Finding an effective way to identify people with mild cognitive impairment who are most likely to go on to develop Alzheimer's disease has eluded researchers for years. But now, a team of researchers led by David Loewenstein, Ph.D., director of the Center for Cognitive Neuroscience and Aging (CNSA) and professor of psychiatry and behavioral sciences at the University of Miami Miller School of Medicine, has devised a novel strategy that could do just that.

The study, "Utilizing Semantic Intrusions to Identify Amyloid Positivity in Mild Cognitive Impairment," funded by the National Institute on Aging, was published in the September issue of *Neurology* and earlier online.

Along with study co-author Rosie E. Curiel, Psy.D., assistant professor of psychiatry and clinical neuropsychology, and their colleagues, Loewenstein studied 88 patients with amnestic mild cognitive impairment (aMCI). They identified 34 people in this cohort with underlying, prodromal Alzheimer's disease (AD) by history and amyloid positive scans. Amyloid-beta is an abnormal protein in the brain long associated with the development of AD.

Among the 54 aMCI participants negative for amyloid-beta, 29 were classified as having a clinical course suggestive of AD but suspected non-AD pathology or "SNAP." The remaining 25 amyloid negative patients had major depression, anxiety or other psychiatric disorders; cerebral infarctions; diffuse Lewy Body disease, or other non-AD neurologic conditions.

The investigators predicted those at greatest risk for AD using the Loewenstein-Acevedo Scales for Semantic Interference and Learning (LASSI-L), a tool developed at the University of Miami. The LASSI-L allowed researchers to uncover specific memory deficits that aligned with

imaging findings for abnormal brain amyloid accumulation.

"Developing more sensitive and effective measures to tap the earliest Alzheimer's changes in the brain is essential for providing earlier and more effective treatment, to better understand the neuropathology of the disease, and to monitor emerging interventions," said Loewenstein.

The LASSI-L measure is a novel "cognitive stress test" validated in both English and Spanish. Researchers ask patients to read 15 words. The words come from three categories -- fruits, musical instruments and articles of clothing -- of five words each. They ask participant to repeat the list of words, and then cue their recall by category. A second trial repeats this learning task and the cued recall to strengthen their recall.

Next researchers present a list of 15 different words from the same three categories. The patients are asked to recall these new words as a measure of "proactive semantic interference" (PSI). PSI occurs where there is interference in new learning based on previous learning and correlates with risk of developing AD.

Researchers also present the second word list a second time, and repeat the cued recall. This component of the LASSI-L measures how well people can recover from the proactive semantic interference. It's called failure to recover from PSI (frPSI) -- and a second indicator of AD risk.

A major finding outlined in the Neurology paper was that the amyloid-beta imaging-positive patients committed a significantly higher number of semantic intrusion errors -- specifically on the PSI and frPSI measures -- compared to the SNAP and other non-AD patients.

Traditional cognitive measures to identify AD risk do not include PSI or frPSI, so the LASSI-L may represent a specific, non-invasive test that could successfully differentiate true AD from SNAP, the researchers noted.

"The association of the LASSI-L with amyloid positivity makes it useful in the clinical evaluation of preclinical Alzheimer's disease and for appropriate recruitment for clinical and prevention trials," Loewenstein said. "This also provides an effective and inexpensive way of screening at-risk populations."

The research is ongoing. Curiel received a new federal grant to computerize the LASSI-L and other novel cognitive measures. In addition, current studies are underway to compare progression on the LASSI-L to brain biomarkers such as MRI, fMRI and PET scans, as well as new agents that assess pathology in the brain.

"We are assisting our national and international institutional partners in developing this cognitive stress test for their investigations and clinical practice," Loewenstein said. "It is a goal of our Center for Cognitive Neurosciences and Aging and the University of Miami Miller School of Medicine to be at the forefront of these efforts."

Earlier diagnosis, potential therapy for Huntington's disease suggested in new research -- ScienceDaily

"This could be a good start to developing new promising treatments for Huntington's disease, treatments that could be administered even before signs of the illness appear," said Alexander Osmand, researcher in the Department of Biochemistry and Cellular and Molecular Biology at the University of Tennessee, Knoxville, and coauthor of the study.

The disease, which causes the progressive deterioration of both mental and physical abilities, is the result of a genetic mutation of the huntingtin gene. All humans possess this gene, and studies suggest that is necessary to healthy development. Its mutated form, however, causes the rapid decay of specific neurons, eventually resulting in death.

Usually, the effects of Huntington's disease are not apparent until an adult reaches their 30s or 40s. By studying mice, however, researchers have discovered that an array of effects may be seen much earlier.

Although these early symptoms are less clearly defined than the later, more debilitating effects, they could serve as an indicator to health care providers that further screening may be needed.

Researchers subjected several litters of mice carrying the human huntingtin gene to four different dose regimens of Panobinostat, a drug currently used in the treatment of various cancers. Researchers believe that this drug can regulate gene expression, which could be an important step towards treating those with Huntington's disease.

The researchers also studied the mice's behavior by monitoring their vocalization, startle response, and risk-taking behavior. These behavioral abnormalities showed that symptoms of the disease were present prior to the

full mutation commonly associated with Huntington's.

Although treatment with Panobinostat cannot reverse gene mutation completely, clinical trials have shown that it may prevent gene changes associated with the expression of the disease. Until now doctors have been able to treat only some of the symptoms associated with Huntington's disease, such as depression, mood swings, and involuntary movement. While these treatments may make Huntington's easier to bear, they do nothing to combat the disease itself.

Approximately 30,000 Americans suffer from the disease, according to the Huntington's Disease Society of America, and one 2013 study found that treatment can cost anywhere from $4,947 to $37,495 annually depending on the severity of the condition.

Story Source:

Materials provided by **University of Tennessee at Knoxville**. *Note: Content may be edited for style and length.*

Measuring the nanoworld -- ScienceDaily

A worldwide study involving 20 laboratories has established and standardized a method to measure exact distances within individual biomolecules, down to the scale of one millionth of the width of a human hair. The new method represents a major improvement of a technology called single-molecule FRET (Förster Resonance Energy Transfer), in which the movement and interaction of fluorescently labelled molecules can be monitored in real time even in living cells. So far, the technology has mainly been used to report changes in relative distances -- for instance, whether the molecules moved closer together or farther apart.

Prof. Dr. Thorsten Hugel of the Institute of Physical Chemistry and the BIOSS Centre for Biological Signalling Studies is one of the lead scientists of the study, which was recently published in *Nature Methods*.

FRET works similarly to proximity sensors in cars: the closer the object is, the louder or more frequent the beeps become. Instead of relying on acoustics, FRET is based on proximity-dependent changes in the fluorescent light emitted from two dyes and is detected by sensitive microscopes. The technology has revolutionised the analysis of the movement and interactions of biomolecules in living cells.

Hugel and colleagues envisioned that once a FRET standard had been established, unknown distances could be determined with high confidence. By working together, the 20 laboratories involved in the study refined the method in such a way that scientists using different microscopes and analysis software obtained the same distances, even in the sub-nanometer range.

"The absolute distance information that can be acquired with this method now enables us to accurately assign conformations in dynamic biomolecules, or even to determine their structures," says Thorsten Hugel, who headed the study together with Dr. Tim Craggs (University of Sheffield/Great-Britain), Prof. Dr. Claus Seidel (University of Düsseldorf) and Prof. Dr. Jens Michaelis (University of Ulm). Such dynamic structural information will

yield a better understanding of the molecular machines and processes that are the basis of life.

Story Source:

Materials provided by **University of Freiburg**. *Note: Content may be edited for style and length.*

New technology improves hydrogen manufacturing -- ScienceDaily

Industrial hydrogen is closer to being produced more efficiently, thanks to findings outlined in a new paper published by Idaho National Laboratory researchers. In the paper, Dr. Dong Ding and his colleagues detailed advances in the production of hydrogen, which is used in oil refining, petrochemical manufacturing and as an eco-friendly fuel for transportation.

The researchers demonstrated high-performance electrochemical hydrogen production at a lower temperature than had been possible before. This was due to a key advance: a ceramic steam electrode that self-assembles from a woven mat.

"We invented a 3D self-assembled steam electrode which can be scalable," said Ding. "The ultrahigh porosity and the 3D structure can make the mass/charge transfer much better, so the performance was better."

In a paper published by the journal *Advanced Science*, the researchers reported on the design, fabrication and characterization of highly efficient proton-conducting solid oxide electrolysis cells (P-SOECs) with a novel 3D self-assembled steam electrode. The cells operated below 600o C. They produced hydrogen at a high sustained rate continuously for days during testing.

Hydrogen is an eco-friendly fuel in part because when it burns, the result is water. However, there are no convenient suitable natural sources for pure hydrogen. Today, hydrogen is obtained by steam reforming (or "cracking") hydrocarbons, such as natural gas. This process, though, requires fossil fuels and creates carbon byproducts, which makes it less suited for sustainable production.

Steam electrolysis, by contrast, needs only water and electricity to split water molecules, thereby generating hydrogen and oxygen. The electricity can

come from any source, including wind, solar, nuclear and other emission-free sources. Being able to do electrolysis efficiently at as low a temperature as possible minimizes the energy needed.

A P-SOEC has a porous steam electrode, a hydrogen electrode and a proton-conducting electrolyte. When voltage is applied, steam travels through the porous steam electrode and turns into oxygen and hydrogen at the electrolyte boundary. Due to differing charges, the two gases separate and are collected at their respective electrodes.

So, the construction of the porous steam electrode is critical, which is why the researchers used an innovative way to make it. They started with a woven textile template, put it into a precursor solution containing elements they wanted to use, and then fired it to remove the fabric and leave behind the ceramic. The result was a ceramic version of the original textile.

They put the ceramic textile in the electrode and noticed that in operation, bridging occurred between strands. This should improve both mass and charge transfer and the stability of the electrode, according to Dr. Wei Wu, the primary contributor to this work.

The electrode and the use of proton conduction enabled high hydrogen production below 600o C. That is cooler by hundreds of degrees than is the case with conventional high-temperature steam electrolysis methods. The lower temperature makes the hydrogen production process more durable, and also requires fewer costly, heat-resistant materials in the electrolysis cell.

Although hydrogen is already used to power vehicles, for energy storage and as portable energy, this approach could offer a more efficient alternative for high-volume production.

Story Source:

Materials provided by **DOE/Idaho National Laboratory**. *Note: Content may be edited for style and length.*

Hormone link between diabetes and hypertension identified -- ScienceDaily

Physician researchers with The Ohio State University College of Medicine at the Wexner Medical Center say increased levels of the hormone aldosterone, already associated with hypertension, can play a significant role in the development of diabetes, particularly among certain racial groups.

"This research is an important step toward finding new ways to prevent a major chronic disease," said Dr. K. Craig Kent, dean of the College of Medicine. "This shows how our diabetes and metabolism scientists are focused on creating a world without diabetes."

Results of this study were published online today by the *Journal of the American Heart Association*.

"Aldosterone is produced by the adrenal gland. We've known for some time that it increases blood pressure. We've recently learned it also increases insulin resistance in muscle and impairs insulin secretion from the pancreas. Both actions increase a person's risk of developing type 2 diabetes, but the question was -- how much," said Dr. Joshua J. Joseph, lead investigator and an endocrinologist at Ohio State Wexner Medical Center.

Joseph and his team followed 1,600 people across diverse populations for 10 years as part of the Multi-Ethnic Study of Atherosclerosis. They found, overall, the risk of developing type 2 diabetes more than doubled for people who had higher levels of aldosterone, compared to participants with lower levels of the hormone. In certain ethnicities, the effect was even greater. African Americans with high aldosterone levels have almost a three-fold increased risk. Chinese Americans with high aldosterone are 10 times more likely to develop diabetes.

"I looked into this as a promise to my father. He had high levels of aldosterone that contributed to his hypertension, and he thought it also might

be linked to his diabetes. As my career progressed, I had the opportunity to research it, and we did find a link to diabetes," Joseph said.

One question that remains is why there are wide differences in risk among various ethnic groups. Joseph said it could be genetics or differences in salt sensitivity or something else, and it needs further study.

Just over 30 million Americans have diabetes and nearly a fourth of them don't know it, according to the Centers for Disease Control and Prevention. Another one in three Americans has prediabetes. Despite current preventive efforts, the numbers continue to climb among various racial/ethnic groups.

Next, Joseph will lead a federally funded clinical trial at Ohio State Wexner Medical Center to evaluate the role of aldosterone in glucose metabolism. African American participants who have prediabetes will take medication to lower their aldosterone levels. Researchers will study the impact on blood glucose and insulin in those individuals.

"We know there's a relationship between aldosterone and type 2 diabetes. Now we need to determine thresholds that will guide clinical care and the best medication for treatment," Joseph said.

He expects to start enrolling patients in that trial later this year.

Story Source:

Materials provided by **The Ohio State University Wexner Medical Center**.
Note: Content may be edited for style and length.

AI beats doctors at predicting heart disease deaths -- ScienceDaily

A model developed using artificial intelligence (AI) is better at predicting risk of death in patients with heart disease than models designed by medical experts, a new study from the Francis Crick Institute shows.

The study, published in *PLOS One*, adds to the growing evidence that AI could revolutionise healthcare in the UK and beyond. So far, the emphasis has been on the potential of AI to help diagnose and treat various diseases, but these new findings suggest it could also help predict the likelihood of patients dying too.

"It won't be long before doctors are routinely using these sorts of tools in the clinic to make better diagnoses and prognoses, which can help them decide the best ways to care for their patients," says Crick scientist Andrew Steele, first author of the paper.

"Doctors already use computer-based tools to work out whether a patient is at risk of heart disease, and machine-learning will allow more accurate models to be developed for a wider range of conditions."

Data-driven model

The model was designed using the electronic health data of over 80,000 patients, collected as part of routine care, and available for researchers on the CALIBER platform.

Scientists at the Crick, working collaboratively with colleagues at the Farr Institute of Health Informatics Research and University College London Hospitals NHS Foundation Trust, wanted to see if they could create a model for coronary artery disease -- the leading cause of death in the UK -- that outperforms experts using self-taught machine learning techniques.

Coronary artery disease develops when the major blood vessels that supply the heart with blood, oxygen and nutrients become damaged, or narrowed by fatty deposits. Eventually restricted blood flow to the heart can lead to chest pain and shortness of breath, while a complete blockage can cause a heart attack.

An expert-constructed prognostic model for coronary artery disease which this work was compared against made predictions based on 27 variables chosen by medical experts, such as age, gender and chest pains. By contrast, the Crick team got their AI algorithms to train themselves, searching for patterns and picking the most relevant variables from a set of 600.

Outperforming experts

Not only did the new data-driven model beat expert-designed models at predicting patient mortality, but it also identified new variables that doctors hadn't thought of.

"Along with factors like age and whether or not a patient smoked, our models pulled out a home visit from their GP as a good predictor of patient mortality," says Andrew. "Home visits are not something a cardiologist might say is important in the biology of heart disease, but perhaps a good indication that the patient is too unwell to make it to the doctor themselves, and a useful variable to help the model make accurate predictions."

This study was a proof-of-principle to compare expert-designed models to machine learning approaches, but a similar model could be implemented in the clinic in the not too distant future.

"Machine learning is hugely powerful tool in medicine and has the ability to revolutionise how we deliver care to patients over the next few years," says Andrew.

Story Source:

Materials provided by **The Francis Crick Institute**. *Note: Content may be edited for style and length.*

DNA technology provides novel strategy for delivery of complex anti-HIV agent: DNA electroporation technology successfully used to direct expression of anti-HIV immunoadhesins and to modulate their function in vivo -- ScienceDaily

Scientists at The Wistar Institute have applied their synthetic DNA technology to engineer a novel eCD4-Ig anti-HIV agent and to enhance its potency in vivo, providing a new simple strategy for constructing complex therapeutics for infectious agents as well as for diverse implications in therapeutic delivery. This critical development was published online in the journal *EBio Medicine*.

The development of a safe and effective HIV vaccine has proven critically challenging. Researchers are exploring passive immunization of laboratory-produced immunoadhesins as well as traditional gene therapy methods for delivery of these complex therapeutic molecules. Immunoadhesins are designed antibody-like molecules specifically engineered to efficiently neutralize diverse forms of HIV by binding with high affinity to the virus envelope.

"These complex therapeutics are difficult to deliver through traditional strategies and achieving full activity in vivo using DNA technology is also challenging," said lead researcher David B. Weiner, Ph.D., executive vice president, director of the Vaccine & Immunotherapy Center and W.W. Smith Charitable Trust Professor in Cancer Research at The Wistar Institute. "We demonstrated that a combination of plasmids can be designed to produce a novel protein as well as its modifying enzyme, allowing them to collocate with each other and create a highly functional immunoadhesin."

Electroporation of synthetic DNA (DNA/EP) consists of the application of small, controlled directional electric currents into the skin or muscle to facilitate optimal uptake of DNA molecules and local production of the DNA-encoded proteins. Using this technology, Weiner and colleagues were able to achieve robust and long-term in vivo expression. A single injection of the synthetic DNA formulation produced functional eCD4-Ig for several months in a mouse model.

Previous studies have shown that a particular modification of the immunoadhesins, called sulfation, favors their binding to the HIV envelope; therefore, co-expression of the TPST2 enzyme that operates this modification is necessary to enhance the anti-HIV potency of the produced eCD4-Ig. The team proved the ability of synthetic DNA to encode the TPST2 enzyme as well as the instructions to direct the produced TPST2 to the cell compartment where the eCD4-Ig molecule is manufactured. The combined delivery resulted in production of sulfated eCD4-Ig immunoadhesin that exhibited enhanced potency.

"This is the first report on the use of synthetic DNA to encode an enzyme that can effectively carry out its activity and modulate biological functions of a target protein with high efficiency in vivo," said Weiner.

Collectively, these study results provide an important advancement for the field of HIV immunization and open the path to further applications for in vivo delivery of biologics.

This work was supported by the National Institutes of Health Integrated Preclinical/Clinical AIDS Vaccine Development Program (IPCAVD) grant U19 Al109646-04. Additional funding was provided by the Martin Delaney Collaboratory for HIV Cure Research and the W.W. Smith Charitable Trust Foundation.

Ziyang Xu from The Wistar Institute and Megan C. Wise from Inovio Pharmaceuticals, Inc., are first co-authors of this study. Other co-authors from Wistar include Hyeree Choi, Alfredo Perales-Puchalt, Ami Patel, Edgar Tello-Ruiz, Jacqueline D. Chu, and Kar Muthumani.

Story Source:

Materials provided by **The Wistar Institute**. *Note: Content may be edited for style and length.*

You act most like 'you' in a time crunch, study finds: Under time pressure, selfish people act even more selfishly -- ScienceDaily

When they must act quickly, selfish people are likely to act more selfishly than usual, while pro-social people behave even more pro-socially, a new study found.

The results suggest that when people don't have much time to make a decision, they go with what they've done in similar situations, said Ian Krajbich, co-author of the study and assistant professor of psychology and economics at The Ohio State University.

"People start off with a bias of whether it is best to be selfish or pro-social. If they are rushed, they'll tend to go with that bias," Krajbich said.

But when people have more time to decide, they are more likely to go against their bias as they evaluate the options in front of them, he said.

Krajbich conducted the study with Fadong Chen of Zhejiang University in China. Their results were published Sept. 3 in the journal *Nature Communications*.

The study involved 102 college students from the United States and Germany who played 200 rounds of a game that is often used in psychology and economics experiments. In each round, played on a computer, the participants chose between two ways of splitting up a real sum of money. Both choices favored the person playing the game, but one choice shared more of the money with the unseen partner.

"The participants had to decide whether to give up some of their own money to increase the other person's payoff and reduce the inequality between

them," Krajbich said.

The decision scenarios were very different. In some cases, the participants would have to give up only, say, $1 to increase their partner's payoff by $10. In others, they might have to give up $1 to give their partner an extra $1. And in other cases, they would have to make a large sacrifice -- for example, give up $10 to give their partner an extra $3.

The key to this study is that participants didn't always have the same amount of time to decide, Krajbich said.

In some cases, participants had to decide within two seconds how they would share their money as opposed to other cases, when they were forced to wait at least 10 seconds before deciding. And in additional scenarios, they were free to choose at their own pace, which was usually more than two seconds but less than 10.

The researchers used a model of the "normal" decisions to predict how a participant's decisions would change under time pressure and time delay.

"We found that time pressure tends to magnify the predisposition that people already have, whether it is to be selfish or pro-social," Krajbich said.

"Under time pressure, when you have very little time to decide, you're going to lean more heavily than usual on your predisposition or bias of how to act."

The situation was different when participants were forced to wait 10 seconds before deciding.

"People may still approach decisions with the expectation that they will act selfishly or pro-socially, depending on their predisposition. But now they have time to consider the numbers and can think of reasons to go against their bias," he said.

"Maybe you're predisposed to be selfish, but see that you only have to give up $1 and the other person is going to get $20. That may be enough to get you to act more pro-socially."

The results may help explain why some previous studies found that time pressure makes people more selfish, while others found that it makes people more pro-social.

"It really depends on where you're starting, on how you're predisposed to decide," Krajbich said.

Story Source:

Materials provided by **Ohio State University**. Original written by Jeff Grabmeier. *Note: Content may be edited for style and length.*

The gens isiaca in Hispania: Egyptian gods in Roman Spain -- ScienceDaily

This database has been created by the Historiography and History of Religions research group from UC3M, under the leadership of Ancient History professor Jaime Alvar, in collaboration with the university's Library Service. The project enables the classification and geo-location of a set of archaeological pieces related to the goddess Isis, recovered from the three provinces of Roman Hispania (Baetica, Lusitania and Tarraconensis) between the 1st cent. BCE and the 3rd cent. CE.

Part of its innovation is its magnitude, as it triples the number of pieces registered on this topic from previous catalogues: "The main advantages are that it provides direct access to ground-breaking information and the immediate update of datasheets." There is no need to wait for a new paper edition. What is more, the geo-location allows any abnormal distribution of materials to be observed. Practically the entire centre of the Iberian Peninsula has no findings, since they are mainly concentrated on the Catalan coast, in Occidental Andalusia and the capital of Lusitania, Mérida," explains Jaime Alvar.

One of the aims of this research is to analyse the conditions of the reception of cultural change and the re-appropriation process of ancient rituals: "How do different sociocultural strata of a community which has been invaded and cross-cultured as a consequence of the Roman conquest act?" You can see how active oligarchies are in the process of generation of social change, or how dominated social groups are less interested in it," Alvar points out.

The development of the database has been carried out in two stages: an initial stage of design, development, inclusion of content and processing of images, and a second stage of geo-location through a personalised Google map where the location of each of the items is determined. "We have created a kind of dialogue between the database and the geo-location, in such a way that if you access the description of the piece you can click on the link and go to the map

to see where it was located and where it is being stored" notes Inmaculada Muro, in charge of research support for the UC3M Humanities Library.

With regards to the Library's collaboration on the project, Teresa Malo, manager of the UC3M Library Service, stresses that the libraries "are no longer simply a warehouse storing knowledge but have rather become a factor in the spreading of knowledge."

The database updates and expands on what is covered in Jaime Alvar's book Los cultos egipcios en Hispania (2012) (Egyptian cults in Hispania), with the advantages of the digital environment: "It allows you to update, modify, correct, delete or add information to the existing datasheets or to other new ones, so that the user can know how recent the data they are viewing is," Jaime Alvar concludes.

In its initial stages, this tool was designed to facilitate the work of specialists in the subject. However, the general public's potential interest in it was later identified: "Some colleagues from the Faculty have already mentioned to me that they had found districts they have an emotional connection with on the map, which lead them to look at which materials had been found in that place. That is to say, it is also entertaining for a non-expert," Alvar comments.

This research is being developed within the framework of the "Oriental Religions in Spain" (ORINS) project, funded by the Ministry of Economy and Competition, for the publication of online catalogues of the cults of the gens isiaca, of Mithras, and of Mater Magna in Hispania. What is more, they have collaborated with the ARYS Association: Antigüedad, Religiones y Sociedades (Antiquity, Religions and Societies), the Institut de Sciences et Techniques de l'Antiquité de l'Université de Franche-Comté (ISTA) and the Dykinson publishing house as co-editor.

Video: https://www.youtube.com/watch?v=UTV3yoM5_g0

Story Source:

Materials provided by **Universidad Carlos III de Madrid**. *Note: Content may be edited for style and length.*

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Reducing nitrogen inputs prevents algal blooms in lakes: Less is more: reduced nitrogen has greater potential than originally thought -- ScienceDaily

For decades, experts have debated whether reducing the amount of nitrogen flowing into lakes can improve water quality in the long-term, even though blue-green algae can bind nitrogen from the air. However, no lakes with decreased nitrogen inputs have been monitored for long enough to clarify this -- until now: scientists from the Leibniz-Institute of Freshwater Ecology and Inland Fisheries (IGB) have analysed long-term data to prove that decreasing nitrogen in Berlin's Lake Müggelsee is the key to reducing algal blooms in summer. They showed that the amount of atmospheric nitrogen bound by blue-green algae is far too small to be used as an argument against the ecologically necessary reduction of nitrogen inputs.

In the 1970s, scientists discovered that nutrient inputs -- mainly phosphorus and nitrogen -- from agriculture and wastewater discharge were the main cause of excessive plant and algal growth in lakes and rivers. Since then, water management experts have concentrated on reducing phosphorus inputs. "Although this strategy often works, it is by no means always successful. In shallow lakes, the sediment releases large quantities of phosphorus in summer. In these cases, reducing nitrogen input may help to control algal blooms because algae need both phosphorus and nitrogen to grow. Until now, however, there has been no convincing evidence that decreasing nitrogen inputs, which is more complex and costly than decreasing phosphorus, works in the long term," stated IGB freshwater ecologist Dr. Tom Shatwell, explaining the starting point of the study.

Long-term data provide deep insight

To conduct their investigation, the scientists statistically analysed 38 years of

data (1979-2016). Since the 1970s, Lake Müggelsee (in Berlin, Germany) and its tributaries have been sampled on a weekly basis as part of a long-term programme to investigate phosphorus and nitrogen concentrations as well as the species composition in algal communities. Müggelsee is one of the few lakes in the world that have experienced a significant decrease in phosphorus and nitrogen pollution and that have been monitored for a sufficiently long time to draw conclusions on the effects of reducing nitrogen inputs.

Every summer, there was an excess of phosphorus in the water of Lake Müggelsee. The scientists concluded it was the decrease in nitrogen that caused algae blooms to decrease -- and water clarity to increase. Contrary to common views, blue-green algae species did not replace the nitrogen missing from the tributaries with nitrogen from the atmosphere in the long term. In fact, blue-green algae did not increase in abundance and there was very little binding of atmospheric nitrogen. "It takes much more energy to fix atmospheric nitrogen than it does to use nitrogen compounds present in the water. Blue-green algae obviously only use this method when absolutely necessary and when there is sufficient solar energy," explained Dr. Jan Köhler, co-author and leader of the "Photosynthesis and Growth of Phytoplankton and Macrophytes" research group at IGB.

Story Source:

Materials provided by **Forschungsverbund Berlin**. *Note: Content may be edited for style and length.*

Attention network plays key role in restoring vision after brain damage: New study highlights the role of attention as a component of vision restoration training in hemianopia -- ScienceDaily

About one third of patients who have suffered a stroke end up with low vision, losing up to half of their visual field. This partial blindness was long considered irreversible, but recent studies have shown that vision training after optic nerve and brain damage can help restore or improve vision. A new study published in the journal *Clinical Neurophysiology* reports on key mechanisms of vision restoration: attention.

Hemianopia is a decreased vision or blindness in half the visual field, usually as a consequence of stroke or trauma to the brain. It greatly reduces quality of life, affecting patients' reading, driving and spatial navigation.

"Knowledge in this field is still rather fragmentary, but recent studies have shown that vision can be partially restored by vision training, which improves the deficient visual field sectors," explains Prof. Bernhard Sabel, PhD, Director of the Institute of Medical Psychology at Magdeburg University, Germany, co-investigator of the study. "Neuroimaging evidence supports a possible role of attention in this vision restoration."

The study confirmed this hypothesis by obtaining evidence from functional magnetic resonance imaging (fMRI) that visual training led to functional connectivity reorganization of the brain´s attentional network.

Seven chronic hemianopic patients with lesions of the visual cortex took part in vision rehabilitation training for five weeks. After the pre-tests all received training sessions lasting one and a half hours per day for six days per week for five weeks. Each training session, lasting about 60 minutes, was

composed of six blocks with 120 training trials each, during which participants had to respond to specially designed visual stimuli on a computer monitor. The pre- and post-test included perimetry testing, contrast sensitivity testing and fMRI scanning one or two days before and after training, respectively. Each contrast sensitivity test consisted of 420 trials in six blocks. The visual rehabilitation training was performed with one eye open, which was randomly chosen, while the non-trained eye was covered with an opaque eye patch.

After training, the patients had significantly improved visual function at the training location, and fMRI showed that the training led to a strengthening of the cortical attentional network connections between the brain region of the right temporoparietal junction (rTPJ) and the insula and the anterior cingulate cortex (ACC).

"Our MRI results highlight the role of attention and the right TPJ activation as a component of vision restoration training in hemianopia," notes lead investigator Yifeng Zhou, DSc, of the Hefei National Laboratory for Physical Sciences at Microscale and School of Life Science, University of Science and Technology of China, Hefei, P.R. China, and State Key Laboratory of Brain and Cognitive Science, Institute of Biophysics, Chinese Academy of Sciences, Beijing, P.R. China. "However, it is unclear whether the rehabilitation of attentional networks is the direct result of training or the result of the rebalancing of bottom-up sensory streams, which should be investigated in future studies."

"This discovery that the brain´s attention network is a key mechanism in partially reversing blindness is an exciting advance in the field of restoring vision in the blind, and it opens up new avenues to design new therapies that are even more effective than current methods to help people with low vision or blindness," concludes Prof. Sabel.

A breakthrough for Australia's fish -- ScienceDaily

A research team from the Threatened Species Recovery Hub has made a breakthrough that could help dwindling numbers of Australian freshwater fish species.

Dr Jabin Watson from the University of Queensland says the innovation will allow small and young fish to get past barriers like culverts.

"Simple things like dams, culverts and weirs can be enough to prevent fish from migrating, accessing habitat and even escaping predators," said Dr Watson.

"These kinds of barriers are a major contributor to the declines and local extinctions of many Australian fish species."

Native fish in the Murray Darling Basin are estimated to be at only ten per cent of pre European numbers.

"When streams pass through a culvert -- the pipes under most roads -- the flow is concentrated," Dr Watson said.

"This fast flow can be impossible for many fish to navigate as they simply can't swim that fast for that long.

"Small and young fish are particularly impacted."

The team used a biohydrodynamics laboratory at UQ to test the swimming ability and behaviour of native fish species.

"Many different types of devices have been trialled in Australia to help fish move past barriers like culverts," Dr Watson said.

"Baffles are frequently used, with the aim of giving fish areas to rest along

the way, but our laboratory testing has shown that the turbulence created can really knock fish about and make them disorientated.

"We've discovered a completely new approach that has proved very successful in laboratory trials, enabling small and young fish to navigate fast flows.

"We have taken advantage of a property of fluid mechanics called the boundary layer to create a channel of slower flowing water along one side of the culvert," he said.

"The boundary layer is a thin layer of slower water generated by a fluid moving across a solid surface, such as the bed and walls of a culvert.

"By adding a beam along the culvert wall, we have added another surface close to the culvert corner.

"The boundary layers from these three surfaces merge to create a reduced velocity channel that is large enough for small fish to swim through.

Dr Watson said no native fish species have evolved to cope with things like culverts.

"Strategies that work to improve fish passage provide hope for our freshwater species," Dr Watson concludes.

Story Source:

Materials provided by **University of Queensland**. *Note: Content may be edited for style and length.*

Severely traumatized refugees may not necessarily develop PTSD -- ScienceDaily

Heavily traumatized people such as refugees fleeing war, torture and natural catastrophes may not necessarily develop posttraumatic stress disorder (PTSD), a new study reveals.

Researchers worked with a group of refugees -- half suffering from PTSD, the others not -- and asked them to suppress neutral memories. Results showed that participants who struggled to control these thoughts were more likely to show symptoms of PTSD.

The research raises the question of whether the ability to control memories protects against developing PTSD or if the condition causes an impairment in an individual's ability to control their memories?

Experts at the University of Birmingham, Ruhr-Universität Bochum, the University of Konstanz and Berlin's Max Planck Institute for Human Development worked with 24 refugees from a range of European, African and Asian countries to complete the study, which is published in *Scientific Reports*.

They found that the more severe the PTSD symptoms, the more difficult refugees found suppressing neutral memories. Their study also indicated that efforts to forget the memories caused problems in remembering non-traumatic experiences.

The research indicates that PTSD patient's problems in suppressing traumatic memories relates to dysfunctional gamma frequency activity in the brain -- a discovery that could help to shape more effective treatments.

Dr Simon Hanslmayr, Reader in Cognitive Neuroscience at the University of Birmingham, commented: "Difficulties experienced by people with severe PTSD symptoms when attempting to suppress bad memories is linked to the

ability to regulate gamma frequency brain activity.

"This novel biomarker could help identify risks posed to PTSD patients by memory suppression techniques and assist in adapting and developing psychotherapeutic methods. Our study certainly raises concerns about unwary use of memory suppression in treating PTSD sufferers."

The researchers note that more research is needed into the effects of traumatic stress in refugees. This would help to develop effective medical strategies to deal with the immediate health and socioeconomic challenges posed by high numbers of refugees.

Dr Gerd Waldhauser, from the Institute of Cognitive Neuroscience at Ruhr University Bochum, commented: "Refugees and asylum seekers are often excluded from medical treatment or do not seek help. They are often unable or unwilling to take part in deamanding cognitive neuroscience studies, making data such as ours precious in understanding a rarely-studied population with abundant mental health problems."

PTSD is a disorder characterised by the recurrent and uncontrollable intrusion of traumatic memories. Patients tend to try to suppress these intrusions which can aggravate the condition's symptoms and cause further emotional distress.

Researchers worked with a group of 24 refugees, who took part in a series of tests whilst being observed with magnetoencephalography (MEG) brain imaging technology which registered the different frequencies of brain activity they exhibited.

Story Source:

Materials provided by **University of Birmingham**. *Note: Content may be edited for style and length.*

Individual metering of heating consumption could lead to savings of up to 20 percent -- ScienceDaily

Metering and charging on an individual basis of heating and hot water consumption is at varying levels of development in European countries. The 2012/27/EU Directive on energy efficiency published in 2012 stipulated the compulsory nature of implementing this kind of system across all member states. Despite the 2016 deadline laid down by the directive for the states to transpose the directive into their internal legislation, today "this has not been done here; right now, there is a draft Royal Decree by which the directive will be transposed, but it has yet to be passed," explained Jon Terés, a member of the ENEDI research group at the UPV/EHU's Faculty of Engineering -- Bilbao and one of the authors of this study.

Despite the fact that current legislation does not yet make this compulsory, "an attempt has been made by installation and maintenance companies and even property administrators to encourage individualisation in communities with centralised heating systems, in other words, those in which a heating and domestic hot water system, and cooling, where appropriate, is supplied to more than one end user. That is why there are more and more communities of residents that decide to go ahead with the installation, although the vast majority of buildings with centralised installations built before 1998 still do not have these systems," he said.

The ENEDI research group has conducted a detailed study of the savings to be made through the individualisation of the metering and charging of the heating and water consumed in a block of about 140 flats in Bilbao. As the researcher explained, the aim sought by this study was "to find out how much energy was being saved through this measure in temperate climates. Most of the studies of this type have been carried out in the north of Europe where climate conditions in winter are much harsher. We aimed to see the extent to which the results of these studies could be extrapolated to our climate, where

the winters are much milder."

In the study conducted they compared the community's heating oil consumption during the two years prior to the intervention with the consumption over the two years that followed. "The results revealed energy savings in the building studied of up to 20% during the period studied; these percentages of savings are very similar to those seen in publications focussing on the conditions in the north of Europe. What is more, in this particular case study, the payback period on investment would be about 10 years, perfectly manageable for systems of this type," specified Terés.

Greater control of and flexibility in consumption

The main difference resulting from consumption on an individual basis is that it allows greater flexibility in the use of the heating system and the possibility of adjusting it to the needs of each home; and when the users pay on the basis of consumption, they become more aware of their use of heating and domestic hot water. As a general rule, this awareness underpins the reduction in consumption in the homes in the block.

What happens in communities where consumption is not on an individual basis, is that "the residents are often unable to turn the system on and off, and the heating functions on the basis of what the community has agreed, following criteria with respect to the calendar and time of day, irrespective of whether the homes are occupied or not in that period, or the temperature that each user wants to have in his/her home; the scenario emerges of having the windows open in winter and the heating turned on," specified the researcher. Furthermore, the heating cost is shared out on the basis of criteria that have nothing to do with the consumption made, such as the number of square metres of each flat.

In view of the results, Terés believes that this case study constitutes "an interesting starting point for this type of study in temperate climates. Right now, we are working on the study of individual consumption, because there are some residents who save much more than others, and we would have to conduct the same study on a bigger number of blocks of flats and perhaps taking longer periods of time into consideration to be able to extrapolate and draw general conclusions from the results."

Story Source:

Materials provided by **University of the Basque Country**. *Note: Content may be edited for style and length.*

A quantum gate between atoms and photons may help in scaling up quantum computers -- ScienceDaily

The quantum computers of the future will be able to perform computations that cannot be done on today's computers. These may likely include the ability to crack the encryption that is currently used for secure electronic transactions, as well as the means to efficiently solve unwieldy problems in which the number of possible solutions increases exponentially. Research in the quantum optics lab of Prof. Barak Dayan in the Weizmann Institute of Science may be bringing the development of such computers one step closer by providing the "quantum gates" that are required for communication within and between such quantum computers.

In contrast with today's electronic bits that can only exist in one of two states -- zero or one -- quantum bits known as qubits can also be in states that correspond to both zero and one at the same time. This is called quantum superposition, and it gives qubits an edge as a computer made of them could perform numerous computations in parallel.

There is just one catch: The state of quantum superposition state can exist only as long as it is not observed or measured in any way by the outside world; otherwise all the possible states collapse into a single one. This leads to contradicting requirements: For the qubits to exist in several states at once they need to be well isolated, yet at the same time they need to interact and communicate with many other qubits. That is why, although several labs and companies around the world have already demonstrated small-scale quantum computers with a few dozen qubits, the challenge of scaling up these to the desired scale of millions of qubits remains a major scientific and technological hurdle.

One promising solution is using isolated modules with small, manageable numbers of qubits, which can communicate between them when needed with

optical links. The information stored in a material qubit (e.g. a single atom or ion) would then be transferred to a "flying qubit" -- a single particle of light called a photon. This photon can be sent through optical fibers to a distant material qubit and transfer its information without letting the environment sense the nature of that information. The challenge in creating such a system is that single photons carry extremely small amounts of energy, and the minuscule systems comprising material qubits generally do not interact strongly with such weak light.

Dayan's quantum optics lab in the Weizmann Institute of Science is one of the few groups worldwide that are focused entirely on attacking this scientific challenge. Their experimental setup has single atoms coupled to unique micron-scale silica resonators on chips; and photons are sent directly to these through special optical fibers. In previous experiments Dayan and his group had demonstrated the ability of their system to function as a single-photon activated switch, and also a way to "pluck" a single photon from a flash of light. In the present study, reported in *Nature Physics*, Dayan and his team succeeded -- for the first time -- to create a logic gate in which a photon and an atom automatically exchange the information they carry.

"The photon carries one qubit, and the atom is a second qubit," says Dayan. "Each time the photon and the atom meet they exchange the qubits between them automatically and simultaneously, and the photon then continues on its way with the new bit of information. In quantum mechanics, in which information cannot be copied or erased, this swapping of information is in fact the basic unit of reading and writing -- the "native" gate of quantum communication."

This type of logic gate -- a SWAP gate -- can be used to exchange qubits both within and between quantum computers. As this gate needs no external control fields or management system, it can enable the construction of the quantum equivalent of very large-scale integration (VLSI) networks. "The SWAP gate we demonstrated is applicable to photonic communication between all types of matter-based qubits -- not only atoms," says Dayan. "We therefore believe that it will become an essential building-block in the next generation of quantum computing systems."

Story Source:

Boosting gravitational wave detectors with quantum tricks -- ScienceDaily

A group of scientists from the Niels Bohr Institute (NBI) at the University of Copenhagen will soon start developing a new line of technical equipment in order to dramatically improve gravitational wave detectors.

Gravitational wave detectors are extremely sensitive and can e.g. register colliding neutron stars in space. Yet even higher sensitivity is sought for in order to expand our knowledge about the Universe, and the NBI-scientists are convinced that their equipment can improve the detectors, says Professor Eugene Polzik: "And we should be able to show proof of concept within approximately three years."

If the NBI-scientists are able to improve the gravitational wave detectors as much as they "realistically expect can be done," the detectors will be able to monitor and carry out measurements in an eight times bigger volume of space than what is currently possible, explains Eugene Polzik: "This will represent a truly significant extension."

Polzik is head of Quantum Optics (Quantop) at NBI and he will spearhead the development of the tailor made equipment for gravitational wave detectors. The research -- which is supported by the EU, the Eureka Network Projects and the US-based John Templeton Foundation with grants totaling DKK 10 million -- will be carried out in Eugene Polzik's lab at NBI.

A collision well noticed

News media all over the world shifted into overdrive in October of 2017 when it was confirmed that a large international team of scientists had indeed measured the collision of two neutron stars; an event which took place 140 million light years from Earth and resulted in the formation of a kilonova.

The international team of scientists -- which also included experts from NBI -

- was able to confirm the collision by measuring gravitational waves from space -- waves in the fabric of spacetime itself, moving at the speed of light. The waves were registered by three gravitational wave detectors: the two US-based LIGO-detectors and the European Virgo-detector in Italy.

"These gravitational wave detectors represent by far the most sensitive measuring equipment man has yet manufactured -- still the detectors are not as accurate as they could possibly be. And this is what we intend to improve," says Professor Eugene Polzik.

How this can be done is outlined in an article which Eugene Polzik and a colleague, Farid Khalili from LIGO collaboration and Moscow State University, have recently published in the scientific journal *Physical Review Letters*. And this is not merely a theoretical proposal, says Eugene Polzik:

"We are convinced this will work as intended. Our calculations show that we ought to be able to improve the precision of measurements carried out by the gravitational wave detectors by a factor of two. And if we succeed, this will result in an increase by a factor of eight of the volume in space which gravitational wave detectors are able to examine at present."

A small glass cell

In July of last year Eugene Polzik and his team at Quantop published a highly noticed article in *Nature* -- and this work is actually the very foundation of their upcoming attempt to improve the gravitational wave detectors.

The article in *Nature* centered on 'fooling' Heisenberg's Uncertainty Principle, which basically says that you cannot simultaneously know the exact position and the exact speed of an object.

This has to do with the fact that observations conducted by shining light on an object inevitably will lead to the object being 'kicked' in random directions by photons, particles of light. This phenomenon is known as Quantum Back Action (QBA) and these random movements put a limit to the accuracy with which measurements can be carried out at the quantum level.

The article in *Nature* in the summer of 2017 made headlines because Eugene

Polzik and his team were able to show that it is -- to a large extent -- actually possible to neutralize QBA.

And QBA is the very reason why gravitational wave detectors -- that also operate with light, namely laser light -- "are not as accurate as they could possibly be," as professor Polzik says.

Put simply, it is possible to neutralize QBA if the light used to observe an object is initially sent through a 'filter'. This was what the article in Nature described -- and the 'filter' which the NBI-scientists at Quantop had developed and described consisted of a cloud of 100 million caesium atoms locked-up in a hermetically closed glass cell just one centimeter long, 1/3 of a millimeter high and 1/3 of a millimeter wide.

The principle behind this 'filter' is exactly what Polzik and his team are aiming to incorporate in gravitational wave detectors.

In theory one can optimize measurements of gravitational waves by switching to stronger laser light than the detectors in both Europe and USA are operating with. However, according to quantum mechanics, that is not an option, says Eugene Polzik:

"Switching to stronger laser light will just make a set of mirrors in the detectors shake more because Quantum Back Action will be caused by more photons. These mirrors are absolutely crucial, and if they start shaking, it will in fact increase inaccuracy."

Instead, the NBI-scientists have come up with a plan based on the atomic 'filter' which they demonstrated in the Nature article: They will send the laser light by which the gravitational wave detectors operate through a tailor made version of the cell with the locked-up atoms, says Eugene Polzik: "And we hope that it will do the job."

New way to see dirty underside of glaciers: How freezing sediment influences the sliding speed of glaciers -- ScienceDaily

Accurate projections of sea level rise require sophisticated models for glacier flow, but current approaches do a poor job capturing the physical processes that control how fast glaciers slide over sediments, according to University of Oregon researchers.

In a new study, the UO team, led by postdoctoral researcher Colin Meyer, offered a theoretical approach that helps to shed light on what they call the dirty, dark undersides of glaciers and improve the modeling of ice flow.

Detailed in a July article in the journal *Nature Communications*, the approach captures how the amount of sediment frozen to a glacier's base varies with the underlying water pressure, melting rate and particle size. It helps account for resulting changes in frictional resistance to glacier sliding.

To illustrate their theory, the UO researchers noted that regardless of the size or weight of a glacier, sliding accommodates ice flow that is driven by gravity and adjusts surface slopes so that friction at the bed never exceeds more than about 1 bar of stress.

"This is a longstanding problem," Meyer said. "If we want to forecast what glaciers are going to do in the future, we have to talk about the place that we can't see: the interface between the ice and the bed."

Formulations dating from the early 1950s attributed this upper stress limit to the plastic-like nature of ice deformation. In their paper, however, the UO researchers noted that 50 percent of all glaciers, including those that move the most ice off land in Greenland and Antarctica into the sea, are sliding.

The earlier explanation for 1 bar of frictional stress was based on

observations by Paul Mercanton, a Swiss geophysicist, in 1950 and the analysis of John Nye, now professor emeritus at the University of Bristol in the United Kingdom, in 1952.

"Nye's work carried the caveat that the formula only works for non-sliding areas," said Alan Rempel, a professor in the UO's Department of Earth Sciences and the paper's senior author. "It's not the complete story. It only applies if the glacier is stuck."

Using their new theory, which combined mathematical analysis with satellite data and geological evidence from regions previously covered by ice sheets, the UO team matched the 1 bar limit. The result provided confidence that freezing sediments is the physical process that controls the friction of the ice-sediment interface. The importance of freezing sediment, Meyer said, will be influential in developing more accurate ice flow models.

The theory's incorporation of freezing sediment provides a more complete view of glacial movement, Rempel said. "It focuses on the sliding and should help scientists accurately find the velocity of an advancing or receding glacier."

"If we want to understand how fast sea levels are going to rise, we need to know how fast the ice sheets are going to disintegrate," Meyer said. "We need to understand the role of friction at the base of a big glacier. Does water lubricate the interface or is the glacier frozen to the sediments? This friction sets how fast glaciers can flow."

The rate of sliding, Rempel said, is key to understanding impacts on sea level.

"The hypothesis that we've pushed forward is that the physics of how glacier ice interacts with its bed is exactly the same physics as how ice interacts with dirt in the world around us," Rempel said. "What we've looked at are conditions under which ice will just slide over dirt versus when ice sinks into and takes the dirt along with it."

Incorporating frozen sediment into sliding laws, Rempel said, will lead to more accurate projections of sea level rise based on glacier-related

conditions.

Story Source:

Materials provided by **University of Oregon**. *Note: Content may be edited for style and length.*

Quantum weirdness in 'chicken or egg' paradox -- ScienceDaily

The "chicken or egg" paradox was first proposed by philosophers in Ancient Greece to describe the problem of determining cause-and-effect.

Now, a team of physicists from The University of Queensland and the NÉEL Institute has shown that, as far as quantum physics is concerned, the chicken and the egg can both come first.

Dr Jacqui Romero from the ARC Centre of Excellence for Engineered Quantum Systems said that in quantum physics, cause-and-effect is not always as straightforward as one event causing another.

"The weirdness of quantum mechanics means that events can happen without a set order," she said.

"Take the example of your daily trip to work, where you travel partly by bus and partly by train.

"Normally, you would take the bus then the train, or the other way round.

"In our experiment, both of these events can happen first," Dr Romero said.

"This is called `indefinite causal order' and it isn't something that we can observe in our everyday life."

To observe this effect in the lab, the researchers used a setup called a photonic quantum switch.

UQ's Dr Fabio Costa said that with this device the order of events -- transformations on the shape of light -- depends on polarisation.

"By measuring the polarisation of the photons at the output of the quantum switch, we were able to show the order of transformations on the shape of

light was not set."

"This is just a first proof of principle, but on a larger scale indefinite causal order can have real practical applications, like making computers more efficient or improving communication."

The research was published in *Physical Reviews Letters* by the American Physical Society.

Story Source:

Materials provided by **University of Queensland**. *Note: Content may be edited for style and length.*

Telescope maps cosmic rays in Large and Small Magellanic Clouds -- ScienceDaily

A radio telescope in outback Western Australia has been used to observe radiation from cosmic rays in two neighbouring galaxies, showing areas of star formation and echoes of past supernovae.

The Murchison Widefield Array (MWA) telescope was able to map the Large Magellanic Cloud and Small Magellanic Cloud galaxies in unprecedented detail as they orbit around the Milky Way.

By observing the sky at very low frequencies, astronomers detected cosmic rays and hot gas in the two galaxies and identified patches where new stars are born and remnants from stellar explosions can be found.

The research was published today in *Monthly Notices of the Royal Astronomical Society*, one of the world's leading astronomy journals.

International Centre for Radio Astronomy Research (ICRAR) astrophysicist Professor Lister Staveley-Smith said cosmic rays are very energetic charged particles that interact with magnetic fields to create radiation we can see with radio telescopes.

"These cosmic rays actually originate in supernova remnants -- remnants from stars that exploded a long time ago," he said.

"The supernova explosions they come from are related to very massive stars, much more massive than our own Sun.

"The number of cosmic rays that are produced depends on the rate of formation of these massive stars millions of years ago."

The Large and Small Magellanic Clouds are very close to our own Milky Way -- less than 200,000 light years away -- and can be seen in the night sky

with the naked eye.

ICRAR astronomer Dr Bi-Qing For, who led the research, said this was the first time the galaxies had been mapped in detail at such low radio frequencies.

"Observing the Magellanic Clouds at these very low frequencies -- between 76 and 227MHz -- meant we could estimate the number of new stars being formed in these galaxies," she said.

"We found that the rate of star formation in the Large Magellanic Cloud is roughly equivalent to one new star the mass of our Sun being produced every ten years.

"In the Small Magellanic Cloud, the rate of star formation is roughly equivalent to one new star the mass of our Sun every forty years."

Included in the observations are 30 Doradus, an exceptional region of star formation in the Large Magellanic Cloud that is brighter than any star formation region in the Milky Way, and Supernova 1987A, the brightest supernova since the invention of the telescope.

Professor Staveley-Smith said the results are an exciting glimpse into the science that will be possible with next-generation radio telescopes.

"It shows an indication of the results that we will see with the upgraded MWA, which now has twice the previous resolution," he said.

Furthermore, the forthcoming Square Kilometre Array (SKA) will deliver exceptionally fine images.

"With the SKA the baselines are eight times longer again, so we'll be able to do so much better," Professor Staveley-Smith said.

Breaking osteoporosis: New mechanism activates bone-building cells: On the road to developing new therapeutic drugs for osteoporosis and other bone degenerative diseases -- ScienceDaily

The number of osteoporosis medications that promote bone formation are few compared to those that suppress bone resorption. A research group led by Kumamoto University scientists has discovered that the gene SIRT7 is important for bone formation, and have succeeded in finding a new mechanism to activate gene functions essential for bone formation. The researchers expect that the 'SIRT7-regulated osteoblastogenesis pathway' will be a new therapeutic drug target to treat decreased osteogenesis and osteoporosis.

Background

Osteoporosis is a disease that causes bones to fracture easily due to a reduction in both bone mass and quality. Aging is one of its leading causes, and it is estimated that around 200 million people are affected worldwide. Fractures of the femoral neck -- the connection between the femur and the hip joint -- or of vertebrae can leave a person bedridden which increases the need for care, reduces quality of life and systemic function, and increases mortality.

Bone is a living tissue that is repeatedly broken down (bone resorption) and remade (bone formation) little by little every day. If this balance collapses and bone resorption exceeds bone formation, bone density decreases and can lead to osteoporosis. Several medications are available to treat this disease, but the number of drugs that promote bone formation are far fewer compared to those that suppress bone resorption. The development of therapeutic agents that regenerate bones is highly desired.

Sirtuins are enzymes that play important roles in controlling aging, stress responses, various areas of the metabolism, and several other body functions. In mammals, there are seven types of sirtuins, SIRT1 to SIRT7. Although SIRT7 has been reported to be involved in cancer and lipid metabolism, its role in bone tissue and bone aging was unknown.

Research

Recent experiments performed by a research group led by scientists from Kumamoto University, Japan showed that mice lacking the SIRT7 gene had reduced bone mass. A bone morphometry analysis showed that bone formation and the number of osteoblasts (bone-building cells) had been reduced. Furthermore, the researchers obtained similar results using osteoblast-specific SIRT7 deficient mice, thereby showing that (osteoblast-specific) SIRT7 is important for bone formation.

Reduced bone formation is common in people with osteoporosis, and the mechanism for this reduction is not well known. To clarify the mechanism, the researchers compared sirtuin (SIRT1, 6, and 7) expression in the skeletal tissue of young and old mice, and found that SIRT7 decreased with age. They then considered that this decrease in SIRT7 in the older specimens may be associated with decreased osteogenesis, and may even be a cause of osteoporosis.

When the researchers cultured osteoblasts (in vitro) with decreased SIRT7 expression in their next experiment, the formation of a bone-like mass (calcified nodule) was markedly suppressed compared to cultures of normal osteoblasts. Additionally, the expression of genes indicating osteoblast differentiation was also decreased, thereby revealing that SIRT7 controls the differentiation of osteoblasts.

To clarify the mechanism by which osteoblastic SIRT7 positively regulates the differentiation of osteoblasts, researchers investigated the transcription activity of the gene expression regulatory factor essential for osteoblast differentiation. They found that the transcription activity of SP7 (also known as Osterix), a protein known to induce differentiation of pre-osteoblasts into mature osteoblasts and osteocytes, was markedly decreased in osteoblasts that lacked the SIRT7 gene.

They also realized that to get high transcription activation of SP7/Osterix, it is important for SIRT7 to deacylate the 368th lysine residue of the SP7/Osterix protein. In other words, SIRT7 enhances the transcriptional activity of SP7/Osterix by chemically modifying it (deacylating the 368th lysine residue). Furthermore, the researchers were able to recover osteoblast functionality in the calcified nodule formation by introducing a mutant SP7/Osterix, which deacylated the 368th lysine of SP7/Osterix, into the osteoblasts that had reduced SIRT7 expression.

The research group is confident that their results show a new mechanism for SIRT7 as a deacylating enzyme important for transcriptional activation of the gene expression regulator SP7/Osterix and is essential for osteoblast differentiation.

"In situations where SIRT7 does not work sufficiently, such as in an older individual, osteoblast formation is impaired due to low SP7/Osterix transcriptional activity. We believe that this decreased osteogenesis is associated with osteoporosis," said study leader Dr. Tatsuya Yoshizawa of Kumamoto University. "Our results, show that the regulatory pathway of SIRT7 -- SP7 / Osterix is a promising target for new therapeutic agents to treat decreased osteogenesis and osteoporosis."

This research was published online in *Nature Communications* on 19 July 2018.

* Note: The results of this research are based on collaborative research between Kumamoto University, Tsurumi University, Tokyo Medical and Dental University (Japan), and the Max Planck Institute (Germany).

Simulations reveal role of calcium in titanium implant acceptance -- ScienceDaily

Titanium-based materials are widely used in medical implant technology. Coating the surface of titanium materials with biologically active molecules has recently shown promise to improve how cells adhere to implants and promote tissue regeneration. The mechanisms behind how peptides stick to titanium, however, are not fully understood.

Researchers at Deakin University in Australia found how calcium ions present at the interface between titanium oxide and tissues affect how well peptides bind to the metal. The team reports their findings in a special issue of *Biointerphases*, from AIP Publishing, that is highlighting women in the field of biointerface science. Using recently developed tools in molecular dynamics simulations, the group's findings provide an early understanding in how one day we might use salt's composition to finely tune the reactions between titanium implants and the body.

"This work contributes to a long-running and ongoing effort to identify systematic improvements for load-bearing implant materials," said Tiffany Walsh, an author on the paper. "The binding behaviors we have identified for these peptides in the presence of ions might guide others in the design of new implant coatings."

It is believed that coating titanium surfaces with biomolecules to adhere to host tissues is aided by nearby inorganic ions in the body. Because of their higher positive charge and role in cell signaling, calcium ions are suspected to be particularly helpful.

To tackle these questions, Walsh and her colleagues created a computer model of the oxidized surface of titanium. The group simulated two titanium-binding peptides, Ti-1 and Ti-2, in solutions of calcium chloride and sodium chloride using molecular dynamics simulations. This computation approach approximates and models the interactions between the numerous molecules in

a system. In their model, they relied on an advanced technique called replica exchange with solute tempering that accelerates the exploration of the peptide structures.

The group discovered that positively charged calcium ions helped Ti-1 adhere to the titanium surface by acting as a connector between the negatively charged titanium oxide and asparagine, a residue within the Ti-1 peptide. This process then leads to other residues pinning directly to the titanium oxide surface. For Ti-2, however, calcium ions were found to limit access to the surface.

The data from their simulations point to improved principles for designing peptides with tunable affinity to titanium application. Walsh said she expects that their findings will lead to exploring the titanium-tissue interface further, including molecules with one binding domain for titanium and one for biomolecules.

"Titanium is a common implant material, and our comprehension of how to beneficially modulate the interaction between titanium and living tissue, while very advanced, still has a lot to go," Walsh said. "We want to contribute to this ongoing effort."

Story Source:

Materials provided by **American Institute of Physics**. *Note: Content may be edited for style and length.*

Key differences between the exercise-trained heart and failing heart: This could lead to new predictors and treatments for irregular heartbeat and heart failure -- ScienceDaily

Regular exercise protects patients from heart disease whereas conditions such as high blood pressure can lead to heart failure and Atrial Fibrillation, the most common type of irregular heartbeat.

A study by scientists from Australia's Baker Heart and Diabetes Institute has examined what is happening to the lipids in the heart and circulating blood plasma during exercise compared to a failing heart as a novel way to advance prediction and treatment of heart failure.

This first-of-its-kind study has identified novel lipids in the heart and plasma in a model of exercise compared to heart disease, and found that some of these lipids have potential as new targets for predicting and treating heart failure and Atrial Fibrillation.

With increasing rates of type 2 diabetes and obesity, new prevention, diagnostic and treatment options are critical for heart failure and Atrial Fibrillation.

Heart failure is one of the most costly diseases and is responsible for among the highest rates of hospitalisation. While Atrial fibrillation, which makes the blood flow inside the heart irregular, places an individual at five times the risk of stroke and can be difficult to identify.

The study, published today in *Cell Reports*, examined nearly 600 lipids in the heart and plasma of exercise-trained mice in comparison to mice with a failing heart.

Led by researcher, Dr Yow Keat Tham, and senior authors, Associate Professor Julie McMullen and Professor Peter Meikle, they say what is particularly exciting is the discovery of a number of novel lipids with unknown roles in the heart which may represent new biomarkers and/or drug targets for Atrial Fibrillation and heart failure.

"Whilst many studies have described functional, structural and genetic differences of the exercise- trained heart and diseased heart in the quest to advance prevention and treatment, a mechanism largely unexplored is the regulation of lipids," says Dr Tham.

"Recent advancements in technology however, have allowed for this large-scale profiling work which has opened up an unexplored pathway for the identification of novel biomarkers and drug targets for the failing heart," he says.

"That's why we are excited about this large-scale lipid study which could herald new ways to predict and prevent potentially deadly conditions like heart failure and Atrial Fibrillation."

Story Source:

Materials provided by **Baker Heart and Diabetes Institute**. *Note: Content may be edited for style and length.*

Coral bleaching on Great Barrier Reef not limited to shallow depths -- ScienceDaily

A new study demonstrates that the recent mass coral bleaching on the Great Barrier Reef was not restricted to shallow depths, but also affected deep reefs. Although deep reefs are often considered a refuge from thermal anomalies, the new research highlights limitations to this role and argues that both shallow and deep reefs are under threat of mass bleaching events. Published today in the journal *Nature Communications*, the study focuses on the mass bleaching event in 2016 that caused the death of 30% of shallow-water corals on the Great Barrier Reef. It details how the impacts of this bleaching lessened over depth, but were still substantial on deep reefs.

"During the bleaching event, cold-water upwelling initially provided cooler conditions on the deep reef," says study co-author Dr. Pim Bongaerts, curator of invertebrate zoology and *Hope for Reefs* co-leader at the California Academy of Sciences. "However, when this upwelling stopped towards the end of summer, temperatures rose to record-high levels even at depth."

Lead author Dr. Pedro Frade from the Center of Marine Sciences (CCMAR) says the research team was astounded to find bleached coral colonies down to depths of 131 feet beneath the ocean's surface. "It was a shock to see that the impacts extended to these dimly lit reefs, as we were hoping their depth may have provided protection from this devastating event."

The Great Barrier Reef is known to harbor extensive areas of deep coral reefs that are notoriously difficult to study. Using remotely operated vehicles (ROVs), the team deployed sensors to 328 feet beneath the ocean's surface to characterize how temperature conditions at depth differ from those in shallow habitats.

A team of divers then conducted surveys during the height of bleaching across a number of sites on the northern Great Barrier Reef. They noted that overall, major bleaching and mortality affected almost a quarter of corals at

the deep sampling points, while confirming previous reports of impacts on close to half the shallower corals.

"Unfortunately, this research further stresses the vulnerability of the Great Barrier Reef," says Dr. Ove Hoegh-Guldberg from The University of Queensland, where the study was conducted. "We already established that the refuge role of deep reefs is generally restricted by the limited overlap in species with the shallow reef. However, this adds an extra limitation by demonstrating that the deep reefs themselves are also impacted by higher water temperatures."

The researchers will continue to study how the process of recovery varies between shallow and deep reefs.

Story Source:

Materials provided by **California Academy of Sciences**. *Note: Content may be edited for style and length.*

New clues found to understanding relapse in breast cancer: Tumor mutations found in patients point to progressive disease -- ScienceDaily

A large genomic analysis has linked certain DNA mutations to a high risk of relapse in estrogen receptor positive breast cancer, while other mutations were associated with better outcomes, according to researchers from Washington University School of Medicine in St. Louis, the Baylor College of Medicine and the University of British Columbia.

The knowledge could help predict which patients are most likely to have their cancer return and spread, and could help guide treatment decisions. It also opens the door to developing more aggressive treatments for patients with the newly identified high-risk mutations.

The study appears Sept. 4 in the journal *Nature Communications*.

The researchers analyzed tumor samples from more than 2,500 patients with estrogen receptor positive breast cancer, one of the most common forms of the disease. These cancer cells have receptors that bind to the hormone estrogen in the nucleus of the cell and drive tumor growth.

More than 266,000 women in the United States are diagnosed with invasive breast cancer each year, according to the American Cancer Society, and about 70 percent of cases are estrogen receptor positive.

ER positive breast cancer patients have a number of treatment options that block the estrogen receptor to stop tumor growth. Such hormonal therapies are effective and less toxic than traditional chemotherapy and radiation. But some tumors develop resistance to these treatments, mutating in ways that fuel growth independent of the presence of estrogen. These types of mutations are of great interest because they are responsible for the majority of

deaths due to breast cancer.

"We would like to help doctors identify patients who are likely to do well versus those who are likely to have a recurrence," said first author Obi L. Griffith, PhD, an assistant professor of medicine and an assistant director of The McDonnell Genome Institute at Washington University School of Medicine. "Those with mutations that are associated with a good prognosis may need less intensive therapy than they might otherwise receive. But if a patient's tumor has mutations linked to high risk of relapse, it's useful to know that early so they can be treated with more aggressive therapies or even potential investigational therapies that could be targeted to their specific mutations."

The new study confirmed past work showing that relatively common mutations in genes called MAP3K1 and TP53 had opposite effects on tumor aggressiveness. Patients with MAP3K1 mutations did well, while those with TP53 mutations were likely to have a recurrence. The study also identified three genes -- DDR1, PIK3R1 and NF1 -- with relatively uncommon mutations that were associated with cancer recurrence and spreading.

"Although mutations in DDR1 and NF1 are considered rare, they are associated with early relapse, which makes them much more common in patients who unfortunately die from the disease and, thus, could be critical therapeutic targets," said Matthew J. Ellis, MB, BChir, PhD, of the Baylor College of Medicine. "Their identification also gives us very important molecular clues into the nature of aggressive tumor behavior."

"It is likely that these genes will now be included in gene panel tests, particularly when clinical trials are developed that target these mutations," Ellis added.

One unique element of this study was the age of the samples. Many were over 20 years old, allowing the researchers to know the full history of how the patients fared. But unlike more recent cancer sequencing studies, neither healthy tissue nor blood samples from those patients were collected or stored alongside the tumor. That means the old tumor samples couldn't be compared with normal DNA from the same patients. Comparing the DNA of healthy tissue versus tumor tissue in the same patient can help identify mutations

driving the cancer.

According to co-first author Nicholas C. Spies, a graduate student in Griffith's lab, scientists now have enough healthy genomes sequenced to be able to compare, on a broad population level, normal genomes to cancer genomes and use big data bioinformatics methods to pull out the mutations likely to be driving cancer, even in old samples that can't be directly compared with healthy DNA from the same patient.

The researchers also pointed out the importance of continuing to sequence cancer genomes.

"With all the breast cancer sequencing that's been done, it's tempting to think we've found everything of importance," Griffith said. "But this study tells us there is still more to discover."

This work was supported by a Susan G. Komen Promise grant, number PG12220321; a Cancer Prevention and Research Institute of Texas (CPRIT) Recruitment of Established Investigators award, grant number RR140033; the McNair Medical Institute; Susan G. Komen; the Department of Defense (DOD) Breast Cancer Research Program (BCRP) award, number W81XWH-16-0538; a Komen CCR award, number CCR16380599; the Canadian Cancer Society Research Institute to the NCIC Clinical Trials Group, grant numbers 021039 and 015469; and by the National Cancer Institute, grant numbers NIH NCI K22CA188163 and NIH NCI U01CA209936.

New mechanism for how ALS disease evolves -- ScienceDaily

A mechanism for how the disease amyotrophic lateral sclerosis, or ALS, evolves has been discovered at Umeå University, Sweden. The discovery concerns how proteins with a defect structure spread the deformation to other proteins, according to results in a new thesis. The discovery can open up for novel pharmaceutical developments in the future.

"We've been able to identify two different types of protein aggregates with different structures and propagation abilities. One type gave rise to a more aggressive disease progression, which shows that these aggregates are the driving force in the development of ALS," says Johan Bergh, doctoral student at the Department of Medical Biosciences at Umeå University, Sweden.

Together with the ALS group at Umeå University, Johan Bergh has developed a method of investigating protein aggregates formed in ALS. With this new method, it has then been possible to identify the particular protein aggregates that are driving in the emergence of ALS.

The protein that has been targeted is superoxid dismutas-1, SOD1. It has long been known that mutations in that protein can cause ALS. The goal of the research team was to investigate the way in which the protein contributes to the disease.

In several diseases afflicting the nervous system, such as in Alzheimer's and Parkinson's Disease, new studies show that some proteins assume an abberant structure. Misfolded proteins aggregate and provoke other proteins of the same kind to assume the same structure. In this way, the disease spreads step by step into the nervous system.

"Using the new method, we have shown and confirmed through animal models that the development of ALS follows the same principle as for other severe nervous disorders. Protein aggregates function as a template that

healthy proteins stick to and cause the disease to spread," says Johan Bergh.

In animal models, agregates of the SOD1 protein from animals, as well as humans, have been shown to induce ALS disease. Amyotrophic lateral sclerosis, ALS, is a fatal neurodegenerative disease which afflicts approximately 250 people annually in Sweden. Although the disease has been known for over 100 years, there is still only one medicine with a disease delaying effect available in Sweden.

"Through our new method, I hope that in the future, drugs will be developed specifically aimed at attacking these protein aggregates. Hopefully, research teams focusing on similar diseases will adopt the method. However, we are in an early phase, and developing drugs is a long-term process," says Johan Bergh.

Johan Bergh has a degree in biomedicine and is a medical doctor at Umeå University. He is now completing his doctoral studies at the Department of Medical Biosciences, started in 2010.

Story Source:

Materials provided by **Umea University**. *Note: Content may be edited for style and length.*

How much insects eat: Study uses Herbarium samples to understand link between climate change and insect herbivory -- ScienceDaily

When she set out to understand whether climate changes over the past century might be effecting how much insects were eating various plants, Emily Meineke decided to go straight to the source -- the plants themselves.

A post-doctoral researcher currently working in the lab of Professor of Organismic and Evolutionary Biology and Harvard University Herbaria Director Charles Davis, Meineke is the lead author of a first-of-its-kind study that used herbarium specimens to track insect herbivory across more than a century. The study is described in a September 4 paper published in the *Journal of Ecology*.

In addition to Meineke, the paper is co-authored by Aimée Classen and Nathan Sanders, who are affiliated with the University of Vermont and the Gund Institute for Environment, and Jonathan Davies, an associate professor at University of British Columbia.

Across four species -- shagbark hickory (*Carya ovata*), swamp white oak (*Quercus bicolor*), showy tick trefoil (*Desmodium canadense*) and wild lowbush blueberry (*Vaccinium angustifolium*) -- the study found that specimens collected in the early 2000s were 23 percent more likely to be damaged by insect herbivores than those collected in the early 1900s.

The data also showed that insect damage was greater following warmer winters and at low latitudes, Meineke said, suggesting that the higher temperatures driven by climate change could be a factor driving insect damage.

"The overwhelming pattern is that across these four different plant species,

with different life histories, insect damage is increasing over time," she said. "In New England, it appears that warming in winter is an important factor driving insect herbivory damage overall.

"Knowing that insect damage on these plants is increasing is useful because we might be able to come up with management strategies before it reaches economic levels," she continued. "I think this study is the tip of the iceberg. Now that we know these plants have more damage than they did 100 years ago, we can try to understand what that actually means for plants."

To understand whether herbivory was increasing, Meineke and colleagues developed a detailed system for measuring not just whether specimens showed insect damage, but how much.

"Instead of just outlining the amount of a specimen that we think was removed by insects, or just saying this specimen has damage or doesn't, we actually wanted to be able to quantify it," Meineke said. "To do that, we laid a grid over each specimen, then randomly selected 5 grid cells and marked whether the leaves inside the grid cell were eaten or not, so our approach was a fine-scale measurement."

One of the challenges the study faced, Meineke said, came in understanding exactly what damage in the specimens was caused by insects.

"Vertebrates chomp off either half a leaf or the whole leaf," she said. "That's rare on herbarium specimens. When insects eat the plants before they're collected, the plant leaves a sort of scar around the damage that's analogous to a human scar.

"But the trouble is that the plants are also eaten within herbaria by a suite of herbivores, and particularly for the older specimens that weren't as well protected, we had to figure out a way to tell when specimens had been eaten before they were collected, and this type of scar tissue is found on just about every plant species we looked at."

Armed with those data, Meineke and colleagues developed a model to examine how herbivory changed over more than a century, but ran into another hurdle in the fact that herbarium specimens aren't randomly sampled.

"What you would hope for is to have a random sample across space collected every few years," she said. "But instead we have these sporadic samples. One way we deal with that is to include as many variables in the model as we can, so we included day of year when a specimen was collected, latitude, longitude, and human population density. The idea is that because you have accounted for all of these other variables...that gives you more explanatory power when it comes to the what's happening over time."

In addition to highlighting the connection between a warming climate and insect herbivory, the study also revealed that urbanization can have the opposite effect.

"We know that urbanization has important effects on insects," Meineke said. "There was a study that looked at 16 cities in Europe and found that the prevalence of insect damage is lower inside cities that outside. We found a similar pattern in New England, and even though it did not explain a lot about how much plants were eaten... urbanization is having a localized effect on insect damage. Overall, though, in New England climate change is having a bigger effect.

"What this means for the future, in my opinion, is that as urbanization accelerates locally, it could counteract the effects of climate change in the sense that you might actually see less insect damage in and around urban centers," she continued. "But in more rural forests, you'll see insect damage increasing over time."

While the study serves to illustrate one of the less understood aspects of climate change, Meineke said it also highlights the value of herbarium collections in answering such questions.

"It's hard to quantify the value of these collections," she said. "Because in fact they're invaluable. You can't go back and collect them again, and now these specimens have a renewed value because they can help us understand issues like climate change, invasive species, land use change, and pollution.

"There are debates taking place right now about whether to get rid of physical museum specimens now that many of them are digitized," she added. "But we can't because we don't know what sort of DNA technology or RNA

technology might be available in the future to take advantage of these specimens. Even though they're imperfect and non-randomly sampled, they're the only records we have."

This research was supported with funding from a Discovery Grant from The Natural Sciences and Engineering Research Council of Canada and a National Science Foundation Postdoctoral Research Fellowship in Biology.

Increased chances of successful IVF with 18-20 eggs -- ScienceDaily

The likelihood of childbirth after in vitro fertilization (IVF) treatment increases if 18 to 20 eggs are stimulated to mature in a woman's ovaries, a dissertation at Sahlgrenska Academy, Sweden, shows. That is more eggs than the number aimed at in today's IVF treatments.

"The results can serve as the basis for how hormone stimulation before IVF treatment is designed in the future with the intention of achieving a good balance between effective and medically safe treatment," says Asa Magnusson, MD/PhD at Sahlgrenska University Hospital and Sahlgrenska Academy.

To an increasing extent both in Sweden and internationally, only one fertilized egg, or embryo, is retrieved per treatment occasion. If the treatment results in more high-quality embryos, these can be frozen and used in later attempts.

Previous research on the total number of eggs that should be retrieved have indicated that the chance of birth after IVF is optimal after about 10 eggs. It has been believed that a greater number of eggs leads not to a better chance of birth but rather to an increased risk of serious side effects.

However, the studies carried out have mainly examined the delivery rate after the first implantation, called the fresh IVF cycle, which takes place just days after the egg retrieval. Later implants of thawed embryos have not been included.

"It's more relevant to study the cumulative chance of children per IVF attempt when all embryo transfers that are generated from an egg retrieval are included," Asa says. "However, it's also important to study the risks in relation to the number of retrieved eggs and serious side effects, both during the stimulation and also neonatal pregnancy and childbirth complications."

The study does not show any connection between egg retrieval and complications for the children. On the other hand, there is a weak but statistically valid correlation between the number of retrieved eggs and placenta previa, a condition that can cause bleeding during pregnancy or childbirth.

The transfer of thawed embryos accounts for about one-third of all IVF cycles in Sweden, and the chance of birth is now comparable with the transfer of fresh embryos. It can thus be beneficial to design hormone stimulation before egg retrieval so that extra embryos can be produced and frozen to avoid additional hormone treatment.

To study the relationship between the number of collected eggs, cumulative delivery rate and serious complications associated with the stimulation, such as ovarian hyperstimulation syndrome and blood clots, treatment data from the Swedish National Quality Registry of Assisted Reproduction (Q-IVF) has been matched with data from the Swedish Patient Register and the Swedish Medical Birth Register for the 2002-2015 period.

"Previously about 10 eggs has been considered optimal for the chance of childbirth after the fresh cycle. We observed that the cumulative chance rose with an increased number of eggs, up to 18-20, and then leveled off. At the same time, the risk of complications remained at a reasonable level up to 18-20 eggs. At a higher number of eggs, the risks increased," Asa Magnusson says.

Title: Ovarian stimulation for IVF- a balance between efficacy and safety; http://hdl.handle.net/2077/55398

Story Source:

Materials provided by **University of Gothenburg**. *Note: Content may be edited for style and length.*

Veiled supernovae provide clue to stellar evolution -- ScienceDaily

At the end of its life, a red supergiant star explodes in a hydrogen-rich supernova. By comparing observation results to simulation models, an international research team found that in many cases this explosion takes place inside a thick cloud of circumstellar matter shrouding the star. This result completely changes our understanding of the last stage of stellar evolution.

The research team led by Francisco Förster at the University of Chile used the Blanco Telescope to find 26 supernovae coming from red supergiants. Their goal was to study the shock breakout, a brief flash of light preceding the main supernova explosion. But they could not find any signs of this phenomenon. On the other hand, 24 of the supernovae brightened faster than expected.

To solve this mystery, Takashi Moriya at the National Astronomical Observatory of Japan (NAOJ) simulated 518 models of supernovae brightness variations and compared them with the observational results. The team found that models with a layer of circumstellar matter about 10 percent the mass of the Sun surrounding the supernovae matched the observations well. This circumstellar matter hides the shock breakout, trapping its light. The subsequent collision between the supernova ejecta and the circumstellar matter creates a strong shock wave that produces extra light, causing it to brighten more quickly.

Moriya explains, "Near the end of its life, some mechanism in the star's interior must cause it to shed mass that then forms a layer around the star. We don't yet have a clear idea of the mechanism causing this mass loss. Further study is needed to get a better understanding of the mass loss mechanism. This will also be important in revealing the supernova explosion mechanism and the origin of the diversity in supernovae."

These observations were performed by the Blanco Telescope at Cerro Tololo Inter-American Observatory during six nights in 2014 and eight nights in 2015. The simulations by Moriya were performed on the NAOJ Center for Computational Astrophysics PC cluster. This research was published in Nature Astronomy on September 3, 2018.

Story Source:

Materials provided by **National Institutes of Natural Sciences**. *Note: Content may be edited for style and length.*

Satellites more at risk from fast solar wind than a major space storm -- ScienceDaily

Satellites are more likely to be at risk from high-speed solar wind than a major geomagnetic storm according to a new UK-US study published this week in the Journal *Space Weather*.

Researchers investigating the space weather risks to orbiting satellites calculated electron radiation levels within the Van Allen radiation belts. This ring-doughnut-shaped zone wraps around the Earth, trapping charged particles. Geostationary orbit lies inside the Van Allen radiation belts

The study, which analysed years of satellite data, found that electron radiation levels at geostationary orbit could remain exceptionally high for 5 days or more, even after the solar wind speed had died down. As a result, electronic components on satellites could charge up to dangerously high levels and become damaged.

Professor Richard Horne, lead author of the study, said:

"Until now we thought that the biggest risk to orbiting satellites was geomagnetic storms. Our study constructed a realistic worst-case event by looking at space weather events caused by high-speed solar wind flowing away from the Sun and striking the Earth. We were surprised to discover just how high electron radiation levels can go."

This new research is particularly interesting to the satellite industry. Professor Horne continues:

"Fast solar wind is more dangerous to satellites because the geomagnetic field extends beyond geostationary orbit and electron radiation levels are increased all the way round the orbit -- in a major geomagnetic storm the field is distorted and radiation levels peak closer to the Earth.

"Electronic components on satellites are usually protected from electrostatic charges by encasing them in metal shielding. You would have to use about 2.5 mm of aluminium to reduce charging to safe levels -- much more than is used at present. There are well over 450 satellites in geostationary orbit and so in a realistic worst case we would expect many satellites to report malfunctions and a strong likelihood of service outage and total satellite loss."

Dr Nigel Meredith, a co-author on the study, said:

"A few years ago, we calculated electron radiation levels for a 1 in 150 year space weather event using statistical methods. This study uses a totally different approach but gets a very similar result and confirms that the risk of damage is real."

The solar wind is a stream of particles and magnetic field flowing away from the Sun. It flows around the Earth's magnetic field and excites so-called 'chorus' plasma waves near geostationary orbit. Chorus waves accelerate electrons and form the Van Allen radiation belts. The chorus waves also travel along the geomagnetic field to the Polar Regions where they are detected on the ground at Halley Research Station, Antarctica.

Story Source:

Materials provided by **British Antarctic Survey**. *Note: Content may be edited for style and length.*

Superradiance: Quantum effect detected in tiny diamonds -- ScienceDaily

The effect has been predicted theoretically decades ago -- but it is very hard to provide experimental evidence for it: "Superradiance" is the phenomenon of one atom giving off energy in the form of light and causing a large number of other atoms in its immediate vicinity to emit energy as well at the same time. This creates a short, intense flash of light.

Up until now, this phenomenon could only be studied with free atoms (and with the use of special symmetries). Now, at TU Wien (Vienna), it was measured in a solid-state system. The team used nitrogen atoms, built into tiny diamonds that can be coupled with microwave radiation. The results have now been published in the journal *Nature Physics*.

A bright flash of quantum light

According to the laws of quantum physics, atoms can be in different states. "When the atom absorbs energy, it is shifted into a so-called excited state. When it returns to a lower energy state, the energy is released again in the form of a photon. This usually happens randomly, at completely unpredictable points in time," says Johannes Majer, research group leader at the Institute of Atomic and Subatomic Physics (TU Wien). However, if several atoms are located close to each other, an interesting quantum effect can occur: one of the atoms emits a photon (spontaneously and randomly), thereby affecting all other excited atoms in its neighborhood. Many of them release their excess energy at the same moment, producing an intense flash of quantum light. This phenomenon is called "superradiance."

"Unfortunately, this effect cannot be directly observed with ordinary atoms," says Andreas Angerer, first author of the study. "Super radiance is only possible if you place all the atoms in an area that is significantly smaller than the wavelength of the photons." So you would have to focus the atoms to less than 100 nanometers -- and then, the interactions between the atoms would be

so strong that the effect would no longer be possible.

Defects in the diamond lattice

One solution to this problem is using a quantum system that Majer and his team have been researching for years: tiny defects built into diamonds. While ordinary diamonds consist of a regular grid of carbon atoms, lattice defects have been deliberately incorporated into the diamonds in Majer's lab. At certain points, instead of a carbon atom, there is a nitrogen atom, and the adjacent point in the diamond lattice is unoccupied.

These special diamonds with lattice defects were made in Japan by Junichi Isoya and his team at the University of Tsukuba. They have succeeded in producing the world's highest concentration of these desired defects without causing any other damage. The theoretical basis of the effect was developed by Kae Nemoto (National Institute of Informatics) and William Munro (NTT Basic Research Laboratories) in Tokyo, Japan.

Just like ordinary atoms, these diamond defects can also be switched into an excited state -- but this is achieved with photons in the microwave range, with a very large wavelength. "Our system has the decisive advantage that we can work with electromagnetic radiation that has a wavelength of several centimeters -- so it is no problem to concentrate the individual defect sites within the radius of one wavelength," explains Andreas Angerer.

When many diamond defects are switched to an excited state, it can usually take hours for all of them to return to the lower-energy state. Due to the superradiance effect, however, this happens within about 100 nanoseconds. The first photon that is sent out spontaneously causes all other defect sites to emit photons as well.

Similar to lasers

Superradiance is based on the same basic principle as the laser -- in both cases there is a stimulated emission of photons, triggered by a photon hitting energetically excited atoms. Nevertheless, these are two quite different phenomena: In the laser, a permanent background of many photons is needed, constantly stimulating new atoms. In superradiance, a single photon triggers a

flash of light all by itself.

"In a sense, superradiance is the more interesting effect, from a quantum physics point of view," says Johannes Majer. "Today, many novel quantum effects are studied, in which the entanglement of many particles plays an important role. Superradiance is one of them. I expect that this will lead to something new, which we might call Quantum Technology 2.0 in the next few decades."

Cathode fabrication for oxide solid-state batteries at room temperature: Thick-film cathode solidified on garnet-type oxide solid electrolyte at room temperature -- ScienceDaily

Researchers at the Toyohashi University of Technology have successfully fabricated a lithium trivanadate (LVO) cathode thick film on a garnet-type oxide solid electrolyte using the aerosol deposition method. The LVO cathode thick-film fabricated on the solid electrolyte showed a large reversible charge and discharge capacity as high as 300 mAh/g and a good cycling stability at 100 ºC. This finding may contribute to the realization of highly safe and chemically stable oxide-based all-solid-state lithium batteries. The research results were reported in *Materials* on September 1st, 2018.

Rechargeable lithium-ion batteries (LiBs) have been widely utilized globally as a power source for mobile electronic devices such as smart phones, tablets, and laptop computers because of their high-energy density and good cycling performance. Recently, the development of middle- and large-scale LiBs has been accelerated for use in automotive propulsion and stationary load-leveling for intermittent power generation from solar or wind energy. However, a larger battery size causes more serious safety issues in LIBs; one of the main reasons is the increased amount of flammable organic liquid electrolytes.

All-solid-state LiBs with nonflammable inorganic Li-ion (Li^+) conductors as solid electrolytes (SE) are expected to be the next generation of energy storage devices because of their high energy density, safety, and reliability. The SE materials must have not only high lithium-ion conductivity at room temperature, but also deformability and chemical stability. Oxide-based SE materials have a relatively low conductivity and poor deformability compared to sulfide-based ones; however, they have other advantages such as chemical

stability and ease of handling.

The garnet-type fast Li+ conducting oxide, Li7-xLa3Zr2-xTaxO12 (x = 0.4-0.5, LLZTO), is considered as a good candidate for SE because of its good ionic conducting property and high electrochemical stability. However, high-temperature sintering at 1000-1200 ºC is generally needed for densification, and this temperature is too high to suppress the undesired side reaction at the interface between SE and the majority of electrode materials. Therefore, there are currently limited electrode materials that can be used for solid-state batteries with garnet-type SEs developed by the co-sintering process.

Ryoji Inada and his colleagues at the Department of Electrical and Electronic Information Engineering, Toyohashi University of Technology, succeeded in fabricating a lithium trivanadate (LiV3O8, LVO) thick-film cathode on garnet-type LLZTO by using the aerosol deposition (AD) method. All-solid-state cell samples were prepared and tested using the fabricated composite.

The AD method is known to be a room-temperature film-fabrication process, which uses the impact-consolidation of ceramic particles onto a substrate. By controlling the particle size and morphology, dense ceramic thick films can be fabricated on various substrates without thermal treatment. This feature is attractive in the fabrication of oxide-based solid-state batteries because various electrode active materials can be selected and formed on SE with no thermal treatment.

LVO has been studied at length as a cathode material for Li-based batteries because of its large Li+ storage capacity of approximately 300 mAh/g. However, the feasibility of LVO as a cathode for solid-state batteries has not yet been investigated. The reaction of LVO initiates at the discharging (i.e., Li+ insertion) process, which differs from that of other conventional cathode materials of LiBs such as LiCoO2, LiMn2O4, and LiFePO4. Therefore, graphite anodes, which are widely used in current LiBs, are difficult to use in batteries with LVO cathodes. In solid-state batteries with garnet-type SEs, Li metal electrodes may potentially be used as anodes; thus, LVO would become an attractive candidate for high-capacity cathodes.

To fabricate a dense LVO film on an LLZTO pellet, the size of the LVO particles was controlled by ball-milling. As a result, an LVO thick film with a

thickness of 5-6 μm was successfully fabricated on LLZTO at room temperature. The relative density of the LVO thick film was approximately 85%. For the electrochemical characterization of the LVO thick film as a cathode, Li metal foil was attached on the opposite end face of the LLZTO pellet as an anode to form an LVO/LLZTO/Li structured solid-state cell. The galvanostatic charge (Li+ extraction from LVO) and discharge (Li+ insertion into LVO) properties in an LVO/LLZTO/Li all-solid-state cell were measured at 50 and 100 ºC.

Although the polarization was considerably large at 50 ºC, a reversible capacity of approximately 100 mAh/g was confirmed. With an increase in temperature to 100 ºC, the polarization reduced and the capacity increased significantly to 300 mAh/g at an averaged cell voltage of approximately 2.5 V; this is a typical behavior of an LVO electrode observed in an organic liquid electrolyte. In addition, we confirm that the charge and discharge reactions in the solid-state cell are stably cycled at various current densities. This can be attributed to the strong adhesion between the LVO film fabricated via impact consolidation and the LLZTO and LVO particles in the film.

These results indicate that LVO can potentially be used as a high-capacity cathode in an oxide-based solid-state battery with high safety and chemical stability, even though additional investigation is needed to enhance the performance. Researchers have carried out further studies to realize oxide-based solid-state batteries at lower operating temperatures.

Story Source:

Materials provided by **Toyohashi University of Technology**. *Note: Content may be edited for style and length.*

Powerful tools to solve challenges in bio- and circular economy -- ScienceDaily

VTT Technical Research Centre of Finland has developed an efficient synthetic biology toolbox for industry and research organisations. This toolbox enables, in an unprecedented way, engineering of a diverse range of yeasts and fungi. The toolbox comprises DNA parts which can be easily combined to create new biological systems.

The SES (Synthetic Expression System) toolbox enables expression of genes in yeasts and fungi considerably more efficiently and with better control than has been possible with previous methods. The toolbox is based on DNA components with well-defined functions and the components can be combined as if they were Lego bricks. In this way, molecular machines can be built, for example, for improved control of yeast cell performance in industrial bioprocesses for production of polymer precursors, fuels and medical compounds.

Because the components of the SES toolbox operate the same way in different species, they can be used to engineer species that have attractive properties, but which have due to lack of engineering tools not been studied or used in biotechnology applications in the past.

The SES toolbox is expected to enable development of numerous novel microbial production processes for valorization of various waste materials to higher value compounds. In doing so, the SES toolbox provides important solutions for bio- and circular economy challenges.

Story Source:

Materials provided by **VTT Technical Research Centre of Finland**. *Note: Content may be edited for style and length.*

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All Top News

Top science stories featured on ScienceDaily's home page.

- **Giving tortoises a 'head start'** [周三, 05 9月 03:04]
  Research indicates that head-starting -- raising a species in captivity and releasing it into a protected habitat after it has grown large enough to be less vulnerable to predators -- is a useful intervention for boosting the state's gopher tortoise population.
- **Why we stick to false beliefs: Feedback trumps hard evidence** [周三, 05 9月 03:03]
  Ever wonder why flat earthers, birthers, climate change and Holocaust deniers stick to their beliefs in the face of overwhelming evidence to the contrary? New findings suggest that feedback, rather than hard evidence, boosts people's sense of certainty when learning new things or trying to tell right from wrong.
- **Quantum weirdness in 'chicken or egg' paradox** [周二, 04 9月 23:47]
  The 'chicken or egg' paradox was first proposed by philosophers in Ancient Greece to describe the problem of determining cause-and-effect. Now, a team of physicists has shown that, as far as quantum physics is concerned, the chicken and the egg can both come first.
- **Coral bleaching on Great Barrier Reef not limited to shallow depths** [周二, 04 9月 23:47]
  A new study demonstrates that the recent mass coral bleaching on the Great Barrier Reef was not restricted to shallow depths, but also impacted deep reefs. Although deep reefs are often considered a refuge from thermal anomalies, the new research highlights limitations to this role and argues that both shallow and deep reefs are under threat of mass bleaching events.
- **Veiled supernovae provide clue to stellar evolution** [周二, 04 9月 22:32]
  At the end of its life, a red supergiant star explodes in a hydrogen-rich supernova. By comparing observation results to simulation models, an international research team found that in many cases this explosion takes place inside a thick cloud of circumstellar matter shrouding the star. This result completely changes our understanding of the last stage of stellar evolution.
- **Superradiance: Quantum effect detected in tiny diamonds** [周二, 04 9月 22:32]
  An atom gives off energy and causes many other atoms in its vicinity to emit light as well. This phenomenon is called 'superradiance'. For the first time, this phenomenon has now bean measured in a solid-state system, consisting of tiny diamonds with built-in nitrogen atoms.
- **Greenhouse emissions from Siberian rivers peak as**

permafrost thaws [周二, 04 9月 22:32]
Permafrost soils store large quantities of frozen carbon and play an important role in regulating Earth's climate. Researchers now show that river greenhouse gas emissions rise high in areas where Siberian permafrost is actively thawing.

- **Artificial cells are tiny bacteria fighters** [周二, 04 9月 21:37]
  Newly created artificial cells can kill bacteria.
- **Falling stars hold clue for understanding dying stars** [周二, 04 9月 01:59]
  An international team of researchers has proposed a new method to investigate the inner workings of supernovae explosions. This new method uses meteorites and is unique in that it can determine the contribution from electron anti-neutrinos, enigmatic particles which can't be tracked through other means.
- **Tracking marine migrations across geopolitical boundaries aids conservation** [周一, 03 9月 23:34]
  A new study uses tracking data for 14 species of migratory marine predators, from leatherback turtles to blue whales and white sharks, to show how their movements relate to the geopolitical boundaries of the Pacific Ocean. The results provide critical information for designing international cooperative agreements needed to manage these species.
- **Scientists pioneer a new way to turn sunlight into fuel** [周一, 03 9月 23:33]
  A new study used semi-artificial photosynthesis to explore new ways to produce and store solar energy. They used natural sunlight to convert water into hydrogen and oxygen using a mixture of biological components and human-made technologies.
- **Mud from the deep sea reveals clues about ancient monsoon** [周一, 03 9月 23:33]
  The Sonoran Desert is one of the world's most biodiverse deserts, thanks to the annual monsoon, which provide a source of moisture in addition to seasonal winter rains. Researchers were able to access untapped clues about the monsoon's activity during the last ice age, about 20,000 years ago. Their findings help scientists predict how regional climates may respond to future conditions.
- **Little star sheds light on young planets** [周一, 03 9月 22:17]
  Astronomers discovered a dense disk of material around a young star, which may be a precursor to a planetary system. Their research could vastly improve models of how solar systems form, which would tell us more about our own place in the cosmos.
- **8,000 new antibiotic combinations are surprisingly effective** [周一, 03 9月 22:15]
  Biologists have identified more than 8,00 new combinations of antibiotics that are surprisingly effective. 'We expect several of these combinations, or more, will work much better than existing antibiotics,' said one of the researchers, a professor of ecology and evolutionary biology.

- **A new way to remove ice buildup without power or chemicals** [周六, 01 9月 03:01]
  Researchers have found a way to prevent icing of powerlines, airplanes, wind turbines, and other surfaces with a special coating and the power of sunlight -- no heating or harsh chemicals needed.
- **Sound can be used to print droplets that couldn't be printed before** [周六, 01 9月 03:01]
  Researchers have developed a new printing technology that uses sound waves to control the size of liquid droplets independent of fluid viscosity. This approach could greatly broaden the types of liquids, including biopharmaceuticals, that can be printed drop-on-demand. The researchers used sound waves to generate a highly confined force at the tip of the printer nozzle, which pulls the droplet. The higher the amplitude of the sound waves, the smaller the droplet size.
- **Eating in 10-hour window can override disease-causing genetic defects, nurture health** [周六, 01 9月 01:01]
  Scientists found that mice lacking the biological clocks thought to be necessary for a healthy metabolism could still be protected against obesity and metabolic diseases by having their daily access to food restricted to a 10-hour window.
- **Are vulnerable lions eating endangered zebras?** [周五, 31 8月 23:04]
  Are Laikipia's recovering lions turning to endangered Grevy's zebras (Equus grevyi) for their next meal?
- **Synthetic microbiome? Genetic engineering allows different species of bacteria to communicate** [周五, 31 8月 21:09]
  What if the bacteria that live in your gut could monitor your health, report disease, and produce beneficial molecules? Researchers have gotten one step closer to creating such a 'synthetic microbiome' by engineering different species of bacteria so they can talk to each other. Given that there are over 1,000 different strains of intestinal interlopers in the human gut, such coordination is crucial for the development of systems that can sense and improve human digestive health.
- **Water worlds could support life, study says** [周五, 31 8月 20:35]
  The conditions for life surviving on planets entirely covered in water are more fluid than previously thought, opening up the possibility that water worlds could be habitable, according to a new article.
- **Scientists identify protein that may have existed when life began** [周五, 31 8月 06:01]
  How did life arise on Earth? Researchers have found among the first and perhaps only hard evidence that simple protein catalysts -- essential for cells, the building blocks of life, to function -- may have existed when life began.
- **Dual-layer solar cell sets record for efficiently generating**

power [周五, 31 8月 06:00]
Materials scientists have developed a highly efficient thin-film solar cell that generates more energy than typical solar panels, thanks to its double-layer design.

- **Biomechanics of chewing depend more on animal size, not diet** [周五, 31 8月 02:34]
  Researchers report that the jaw joint bone, the center around which chewing activity revolves (literally), appears to have evolved based more on an animal's size than what it eats.

- **DNA accessibility, gene expression jointly profiled in thousands of cells** [周五, 31 8月 02:32]
  A new assay can concurrently trace, in thousands of different cells, the marks that shape what each cell's genome will do -- the epigenome -- and the copies of the instructions themselves -- the transcriptome. The epigenome and transcriptome are part of the molecular biology that converts the genetic blueprint of DNA into tools and materials for living cells.

- **Most land-based ecosystems worldwide risk 'major transformation' due to climate change** [周五, 31 8月 02:32]
  Without dramatic reductions in greenhouse-gas emissions, most of the planet's land-based ecosystems -- from its forests and grasslands to the deserts and tundra -- are at high risk of 'major transformation' due to climate change.

- **CRISPR halts Duchenne muscular dystrophy progression in dogs** [周五, 31 8月 02:32]
  Scientists for the first time have used CRISPR gene editing to halt the progression of Duchenne muscular dystrophy (DMD) in a large mammal, according to a new study that provides a strong indication that a lifesaving treatment may be in the pipeline.

- **Scientists decode opium poppy genome** [周五, 31 8月 02:31]
  Scientists have determined the DNA code of the opium poppy genome, uncovering key steps in how the plant evolved to produce the pharmaceutical compounds used to make vital medicines. The discovery may pave the way for scientists to improve yields and the disease resistance of the medicinal plant, securing a reliable and cheap supply of the most effective drugs for pain relief and palliative care.

- **Adapt, move or die: How biodiversity reacted to past climate change** [周五, 31 8月 02:31]
  A new paper reviews current knowledge on climate change and biodiversity. In the past, plants and animals reacted to environmental changes by adapting, migrating or going extinct. These findings point to radical changes in biodiversity due to climate change in the future.

- **Climate change projected to boost insect activity and crop loss, researchers say** [周五, 31 8月 02:30]
  Scientists report that insect activity in today's temperate, crop-growing regions will rise along with temperatures. Researchers project that this activity, in turn, will boost worldwide losses of rice, corn and wheat by 10-25 percent for each degree Celsius that global mean surface temperatures rise.

- **Guiding flight: The fruit fly's celestial compass** [周五, 31 8月 00:51]
  Fruit flies use the sun to avoid flying in circles, according to new research.
- **Solar eruptions may not have slinky-like shapes after all** [周四, 30 8月 23:30]
  As the saying goes, everything old is new again. While the common phrase often refers to fashion, design, or technology, scientists have found there is some truth to this mantra even when it comes to research. Revisiting some older data, the researchers discovered new information about the shape of coronal mass ejections (CMEs) -- large-scale eruptions of plasma and magnetic field from the sun -- that could one day help protect satellites in space as well as the electrical grid on Earth.
- **Human genome could contain up to 20 percent fewer genes, researchers reveal** [周四, 30 8月 23:30]
  A new study reveals that up to 20 percent of genes classified as coding (those that produce the proteins that are the building blocks of all living things) may not be coding after all because they have characteristics that are typical of non-coding or pseudogenes (obsolete coding genes). The work once again highlights doubts about the number of real genes present in human cells 15 years after the sequencing the human genome.
- **Deadline for climate action: Act strongly before 2035 to keep warming below 2°C** [周四, 30 8月 20:48]
  If governments don't act decisively by 2035 to fight climate change, humanity could cross a point of no return after which limiting global warming below 2°C in 2100 will be unlikely, according to a new study. The research also shows the deadline to limit warming to 1.5°C has already passed, unless radical climate action is taken.
- **Engineered sand zaps storm water pollutants** [周四, 30 8月 20:48]
  Engineers have created a new way to remove contaminants from storm water, potentially addressing the needs of water-stressed communities that are searching for ways to tap the abundant and yet underused source of fresh drinking water. The mineral-coated sand reacts with and destroys organic pollutants, providing a way to help purify storm water percolating into underground aquifers, creating a safe and local reservoir of drinking water for parched communities.
- **How a NASA scientist looks in the depths of the great red spot to find water on Jupiter** [周四, 30 8月 03:38]
  One critical question has bedeviled astronomers for generations: Is there water deep in Jupiter's atmosphere, and if so, how much?
- **'Archived' heat has reached deep into the Arctic interior, researchers say** [周四, 30 8月 02:38]
  Arctic sea ice isn't just threatened by the melting of ice around its edges, a new study has found: Warmer water that originated hundreds of miles away has penetrated deep into the interior of the Arctic.
- **Early amber trade: Sicilian amber in Western Europe**

predates arrival of Baltic amber by at least 2,000 years

[周四, 30 8月 02:38]

Amber from Sicily arrived in Iberia as early as the 4th Millennium BC, some 2,000 years before the appearance of Baltic amber to the peninsula. New study also suggests that Baltic amber reached Iberia via the Mediterranean not via direct trade with the North.

- **Protect key habitats, not just wilderness, to preserve species** [周四, 30 8月 02:38]

  Some scientists have suggested we need to protect half of Earth's surface to preserve most of its species. A new study, however, cautions that it's the quality, not merely the quantity, of land we protect that matters. To preserve biodiversity more fully, especially species with small ranges, governments should expand their conservation focus and prioritize key habitats outside wildernesses and current protected areas. The study identifies where some of the most urgent conservation gaps occur.

- **Not so fast: From shrews to elephants, animal reflexes surprisingly slow** [周四, 30 8月 02:37]

  While speediness is a priority for any animal trying to escape a predator or avoid a fall, a new study suggests that even the fastest reflexes among all animals are remarkably slow.

- **Mammal forerunner that reproduced like a reptile sheds light on brain evolution** [周四, 30 8月 01:34]

  Compared with the rest of the animal kingdom, mammals have the biggest brains and produce some of the smallest litters of offspring. A newly described fossil of an extinct mammal relative -- and her 38 babies -- is among the best evidence that a key development in the evolution of mammals was trading brood power for brain power.

- **A recipe for regenerating nerve fibers across complete spinal cord injury** [周四, 30 8月 01:32]

  Scientists have designed a three-stepped recipe for regenerating electro-physiologically active nerve fibers across complete spinal cord lesions in rodents. Rehabilitation is still required to make these new nerve fibers functional for walking.

- **Unstoppable monster in the early universe** [周四, 30 8月 01:32]

  Astronomers obtained the most detailed anatomy chart of a monster galaxy located 12.4 billion light-years away. Using the Atacama Large Millimeter/submillimeter Array (ALMA), the team revealed that the molecular clouds in the galaxy are highly unstable, which leads to runaway star formation.

- **Humanmade mangroves could get to the 'root' of the problem for threats to coastal areas** [周三, 29 8月 23:56]

  With threats of sea level rise, storm surge and other natural disasters, researchers are turning to nature to protect humans from nature. Using bioinspired materials that mimic mangrove trees, they are creating mangrove-like structures that can be used for erosion control, coastal protection, and habitat reconstruction. Structures like seawalls are expensive to build, raise environmental concerns, and obstruct the natural landscape. The prototype they have developed is scalable, smaller, simpler …

- **The fate of plastic in the oceans** [周三, 29 8月 23:55]
  The concentrations of microplastics in the surface layer of the oceans are lower than expected. Researchers experimentally demonstrated that microplastics interact with natural particles and form aggregates in seawater. This aggregate formation could explain how microplastics sink into deeper water layers.

- **Cold climates contributed to the extinction of the Neanderthals** [周三, 29 8月 23:55]
  Climate change may have played a more important role in the extinction of Neanderthals than previously believed, according to a new study.

- **The more pesticides bees eat, the more they like them** [周三, 29 8月 08:49]
  Bumblebees acquire a taste for pesticide-laced food as they become more exposed to it, a behavior showing possible symptoms of addiction.

- **Getting to the roots of our ancient cousins' diet** [周三, 29 8月 08:49]
  Since the discovery of the fossil remains of Australopithecus africanus from Taung nearly a century ago, and subsequent discoveries of Paranthropus robustus, there have been disagreements about the diets of these two South African hominin species. By analyzing the splay and orientation of fossil hominin tooth roots, researchers now suggest that Paranthropus robustus had a unique way of chewing food not seen in other hominins.

Giving tortoises a 'head start': Raising gopher tortoises in captivity may boost wild populations -- ScienceDaily

Research from the University of Georgia indicates that head-starting -- raising a species in captivity and releasing it into a protected habitat after it has grown large enough to be less vulnerable to predators -- is a useful intervention for boosting the state's gopher tortoise population, which has been declining in numbers for decades due to predation, poaching and loss of suitable habitat.

Seventy percent of head-started tortoises raised from donor eggs were still alive a year after release at Yuchi Wildlife Management Area in Burke County, according to research by Tracey Tuberville and Dan Quinn. They published their findings in the *Journal of Wildlife Management*.

The gopher tortoise, Georgia's state reptile, is a keystone species whose burrows provide shelter for more than 250 other species, said Tuberville, associate research scientist at the Savannah River Ecology Laboratory and adjunct faculty at the Warnell School of Forestry and Natural Resources.

Despite predation risks at the release site, survival rates were higher than survival reported for their wild counterparts, according to Quinn, a graduate student at SREL and Warnell during the research.

Quinn conducted two soft-releases of yearlings at YWMA during consecutive years. The team said the second release was the largest tortoise release in the state to date.

"We initially released the tortoises into pens to acclimate them into the natural environment," he said. "This gives them time to construct a burrow and in theory it reduces predation risk."

Forty-two of 145 yearlings were radio tracked and monitored for a year following the soft releases, providing information to inform future head-starting efforts.

Tracking data revealed that the juveniles demonstrated a strong rate of site fidelity, remaining together in a protected area, which allows them to reproduce. This means the soft-release technique is not necessary, according to Tuberville.

Instead, the researchers will implement multiple releases in various locations to help reduce predation risk. Predators included fire ants, raccoons and dogs, with fire ants accounting for the majority of fatalities.

Head-starting efforts at YWMA will continue with tortoises that are 2 to 3 years old, an age when they are less susceptible to predators, Tuberville said. Additional research will evaluate whether the positive effect on post-release survival warrants the additional time in captivity.

Story Source:

Materials provided by **University of Georgia**. *Note: Content may be edited for style and length.*

Why we stick to false beliefs: Feedback trumps hard evidence: New study finds that feedback rather than hard evidence makes us more confident that we're right -- ScienceDaily

Ever wonder why flat earthers, birthers, climate change and Holocaust deniers stick to their beliefs in the face of overwhelming evidence to the contrary?

New findings from researchers at the University of California, Berkeley, suggest that feedback, rather than hard evidence, boosts people's sense of certainty when learning new things or trying to tell right from wrong.

Developmental psychologists have found that people's beliefs are more likely to be reinforced by the positive or negative reactions they receive in response to an opinion, task or interaction, than by logic, reasoning and scientific data.

Their findings, published today in the online issue of the journal *Open Mind*, shed new light on how people handle information that challenges their worldview, and how certain learning habits can limit one's intellectual horizons.

"If you think you know a lot about something, even though you don't, you're less likely to be curious enough to explore the topic further, and will fail to learn how little you know," said study lead author Louis Marti, a Ph.D. student in psychology at UC Berkeley.

This cognitive dynamic can play out in all walks of actual and virtual life, including social media and cable-news echo chambers, and may explain why some people are easily duped by charlatans.

"If you use a crazy theory to make a correct prediction a couple of times, you can get stuck in that belief and may not be as interested in gathering more information," said study senior author Celeste Kidd, an assistant professor of psychology at UC Berkeley.

Specifically, the study examined what influences people's certainty while learning. It found that study participants' confidence was based on their most recent performance rather than long-term cumulative results. The experiments were conducted at the University of Rochester.

For the study, more than 500 adults, recruited online through Amazon's Mechanical Turk crowdsourcing platform, looked at different combinations of colored shapes on their computer screens. They were asked to identify which colored shapes qualified as a "Daxxy," a make-believe object invented by the researchers for the purpose of the experiment.

With no clues about the defining characteristics of a Daxxy, study participants had to guess blindly which items constituted a Daxxy as they viewed 24 different colored shapes and received feedback on whether they had guessed right or wrong. After each guess, they reported on whether or not they were certain of their answer.

The final results showed that participants consistently based their certainty on whether they had correctly identified a Daxxy during the last four or five guesses instead of all the information they had gathered throughout.

"What we found interesting is that they could get the first 19 guesses in a row wrong, but if they got the last five right, they felt very confident," Marti said. "It's not that they weren't paying attention, they were learning what a Daxxy was, but they weren't using most of what they learned to inform their certainty."

An ideal learner's certainty would be based on the observations amassed over time as well as the feedback, Marti said.

"If your goal is to arrive at the truth, the strategy of using your most recent feedback, rather than all of the data you've accumulated, is not a great tactic," he said.

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Quantum weirdness in 'chicken or egg' paradox -- ScienceDaily

The "chicken or egg" paradox was first proposed by philosophers in Ancient Greece to describe the problem of determining cause-and-effect.

Now, a team of physicists from The University of Queensland and the NÉEL Institute has shown that, as far as quantum physics is concerned, the chicken and the egg can both come first.

Dr Jacqui Romero from the ARC Centre of Excellence for Engineered Quantum Systems said that in quantum physics, cause-and-effect is not always as straightforward as one event causing another.

"The weirdness of quantum mechanics means that events can happen without a set order," she said.

"Take the example of your daily trip to work, where you travel partly by bus and partly by train.

"Normally, you would take the bus then the train, or the other way round.

"In our experiment, both of these events can happen first," Dr Romero said.

"This is called `indefinite causal order' and it isn't something that we can observe in our everyday life."

To observe this effect in the lab, the researchers used a setup called a photonic quantum switch.

UQ's Dr Fabio Costa said that with this device the order of events -- transformations on the shape of light -- depends on polarisation.

"By measuring the polarisation of the photons at the output of the quantum switch, we were able to show the order of transformations on the shape of

light was not set."

"This is just a first proof of principle, but on a larger scale indefinite causal order can have real practical applications, like making computers more efficient or improving communication."

The research was published in *Physical Reviews Letters* by the American Physical Society.

Story Source:

Materials provided by **University of Queensland**. *Note: Content may be edited for style and length.*

Coral bleaching on Great Barrier Reef not limited to shallow depths -- ScienceDaily

A new study demonstrates that the recent mass coral bleaching on the Great Barrier Reef was not restricted to shallow depths, but also affected deep reefs. Although deep reefs are often considered a refuge from thermal anomalies, the new research highlights limitations to this role and argues that both shallow and deep reefs are under threat of mass bleaching events. Published today in the journal *Nature Communications*, the study focuses on the mass bleaching event in 2016 that caused the death of 30% of shallow-water corals on the Great Barrier Reef. It details how the impacts of this bleaching lessened over depth, but were still substantial on deep reefs.

"During the bleaching event, cold-water upwelling initially provided cooler conditions on the deep reef," says study co-author Dr. Pim Bongaerts, curator of invertebrate zoology and *Hope for Reefs* co-leader at the California Academy of Sciences. "However, when this upwelling stopped towards the end of summer, temperatures rose to record-high levels even at depth."

Lead author Dr. Pedro Frade from the Center of Marine Sciences (CCMAR) says the research team was astounded to find bleached coral colonies down to depths of 131 feet beneath the ocean's surface. "It was a shock to see that the impacts extended to these dimly lit reefs, as we were hoping their depth may have provided protection from this devastating event."

The Great Barrier Reef is known to harbor extensive areas of deep coral reefs that are notoriously difficult to study. Using remotely operated vehicles (ROVs), the team deployed sensors to 328 feet beneath the ocean's surface to characterize how temperature conditions at depth differ from those in shallow habitats.

A team of divers then conducted surveys during the height of bleaching across a number of sites on the northern Great Barrier Reef. They noted that overall, major bleaching and mortality affected almost a quarter of corals at

the deep sampling points, while confirming previous reports of impacts on close to half the shallower corals.

"Unfortunately, this research further stresses the vulnerability of the Great Barrier Reef," says Dr. Ove Hoegh-Guldberg from The University of Queensland, where the study was conducted. "We already established that the refuge role of deep reefs is generally restricted by the limited overlap in species with the shallow reef. However, this adds an extra limitation by demonstrating that the deep reefs themselves are also impacted by higher water temperatures."

The researchers will continue to study how the process of recovery varies between shallow and deep reefs.

Story Source:

Materials provided by **California Academy of Sciences**. *Note: Content may be edited for style and length.*

Veiled supernovae provide clue to stellar evolution -- ScienceDaily

At the end of its life, a red supergiant star explodes in a hydrogen-rich supernova. By comparing observation results to simulation models, an international research team found that in many cases this explosion takes place inside a thick cloud of circumstellar matter shrouding the star. This result completely changes our understanding of the last stage of stellar evolution.

The research team led by Francisco Förster at the University of Chile used the Blanco Telescope to find 26 supernovae coming from red supergiants. Their goal was to study the shock breakout, a brief flash of light preceding the main supernova explosion. But they could not find any signs of this phenomenon. On the other hand, 24 of the supernovae brightened faster than expected.

To solve this mystery, Takashi Moriya at the National Astronomical Observatory of Japan (NAOJ) simulated 518 models of supernovae brightness variations and compared them with the observational results. The team found that models with a layer of circumstellar matter about 10 percent the mass of the Sun surrounding the supernovae matched the observations well. This circumstellar matter hides the shock breakout, trapping its light. The subsequent collision between the supernova ejecta and the circumstellar matter creates a strong shock wave that produces extra light, causing it to brighten more quickly.

Moriya explains, "Near the end of its life, some mechanism in the star's interior must cause it to shed mass that then forms a layer around the star. We don't yet have a clear idea of the mechanism causing this mass loss. Further study is needed to get a better understanding of the mass loss mechanism. This will also be important in revealing the supernova explosion mechanism and the origin of the diversity in supernovae."

These observations were performed by the Blanco Telescope at Cerro Tololo Inter-American Observatory during six nights in 2014 and eight nights in 2015. The simulations by Moriya were performed on the NAOJ Center for Computational Astrophysics PC cluster. This research was published in Nature Astronomy on September 3, 2018.

Story Source:

Materials provided by **National Institutes of Natural Sciences**. *Note: Content may be edited for style and length.*

Superradiance: Quantum effect detected in tiny diamonds -- ScienceDaily

The effect has been predicted theoretically decades ago -- but it is very hard to provide experimental evidence for it: "Superradiance" is the phenomenon of one atom giving off energy in the form of light and causing a large number of other atoms in its immediate vicinity to emit energy as well at the same time. This creates a short, intense flash of light.

Up until now, this phenomenon could only be studied with free atoms (and with the use of special symmetries). Now, at TU Wien (Vienna), it was measured in a solid-state system. The team used nitrogen atoms, built into tiny diamonds that can be coupled with microwave radiation. The results have now been published in the journal *Nature Physics*.

A bright flash of quantum light

According to the laws of quantum physics, atoms can be in different states. "When the atom absorbs energy, it is shifted into a so-called excited state. When it returns to a lower energy state, the energy is released again in the form of a photon. This usually happens randomly, at completely unpredictable points in time," says Johannes Majer, research group leader at the Institute of Atomic and Subatomic Physics (TU Wien). However, if several atoms are located close to each other, an interesting quantum effect can occur: one of the atoms emits a photon (spontaneously and randomly), thereby affecting all other excited atoms in its neighborhood. Many of them release their excess energy at the same moment, producing an intense flash of quantum light. This phenomenon is called "superradiance."

"Unfortunately, this effect cannot be directly observed with ordinary atoms," says Andreas Angerer, first author of the study. "Super radiance is only possible if you place all the atoms in an area that is significantly smaller than the wavelength of the photons." So you would have to focus the atoms to less than 100 nanometers -- and then, the interactions between the atoms would be

so strong that the effect would no longer be possible.

Defects in the diamond lattice

One solution to this problem is using a quantum system that Majer and his team have been researching for years: tiny defects built into diamonds. While ordinary diamonds consist of a regular grid of carbon atoms, lattice defects have been deliberately incorporated into the diamonds in Majer's lab. At certain points, instead of a carbon atom, there is a nitrogen atom, and the adjacent point in the diamond lattice is unoccupied.

These special diamonds with lattice defects were made in Japan by Junichi Isoya and his team at the University of Tsukuba. They have succeeded in producing the world's highest concentration of these desired defects without causing any other damage. The theoretical basis of the effect was developed by Kae Nemoto (National Institute of Informatics) and William Munro (NTT Basic Research Laboratories) in Tokyo, Japan.

Just like ordinary atoms, these diamond defects can also be switched into an excited state -- but this is achieved with photons in the microwave range, with a very large wavelength. "Our system has the decisive advantage that we can work with electromagnetic radiation that has a wavelength of several centimeters -- so it is no problem to concentrate the individual defect sites within the radius of one wavelength," explains Andreas Angerer.

When many diamond defects are switched to an excited state, it can usually take hours for all of them to return to the lower-energy state. Due to the superradiance effect, however, this happens within about 100 nanoseconds. The first photon that is sent out spontaneously causes all other defect sites to emit photons as well.

Similar to lasers

Superradiance is based on the same basic principle as the laser -- in both cases there is a stimulated emission of photons, triggered by a photon hitting energetically excited atoms. Nevertheless, these are two quite different phenomena: In the laser, a permanent background of many photons is needed, constantly stimulating new atoms. In superradiance, a single photon triggers a

flash of light all by itself.

"In a sense, superradiance is the more interesting effect, from a quantum physics point of view," says Johannes Majer. "Today, many novel quantum effects are studied, in which the entanglement of many particles plays an important role. Superradiance is one of them. I expect that this will lead to something new, which we might call Quantum Technology 2.0 in the next few decades."

Greenhouse emissions from Siberian rivers peak as permafrost thaws -- ScienceDaily

As permafrost degrades, previously frozen carbon can end up in streams and rivers where it will be processed and emitted as greenhouse gases from the water surface directly into the atmosphere. Quantifying these river greenhouse gas emissions is particularly important in Western Siberia -- an area that stores vast amounts of permafrost carbon and is a home to the Arctic's largest watershed, Ob' River.

Now researchers from Umeå University (and collaborators from SLU, Russia, France, and United Kingdom) have shown that river greenhouse gas emissions peak in the areas where Western Siberian permafrost has been actively degrading and decrease in areas where climate is colder, and permafrost has not started to thaw yet. The research team has also found out that greenhouse gas emissions from rivers exceed the amount of carbon that rivers transport to the Arctic Ocean.

"This was an unexpected finding as it means that Western Siberian rivers actively process and release large part of the carbon they receive from degrading permafrost and that the magnitude of these emissions might increase as climate continues to warm" says Svetlana Serikova, doctoral student in the Department of Ecology and Environmental sciences, Umeå University, and one of the researchers in the team.

Quantifying river greenhouse gas emissions from permafrost-affected areas in general and in Western Siberia in particular is important as it improves our understanding the role such areas play in the global carbon cycle as well as increases our abilities of predicting the impacts of a changing climate on the Arctic.

"The large-scale changes that take place in the Arctic due to warming exert a strong influence on the climate system and have far-reaching consequences for the rest of the world. That is why it is important we focus on capturing

how climate warming affects the Arctic now before these dramatic changes happen" says Svetlana Serikova.

Story Source:

Materials provided by **Umea University**. *Note: Content may be edited for style and length.*

Artificial cells are tiny bacteria fighters -- ScienceDaily

"Lego block" artificial cells that can kill bacteria have been created by researchers at the University of California, Davis Department of Biomedical Engineering. The work is reported Aug. 29 in the journal *ACS Applied Materials and Interfaces*.

"We engineered artificial cells from the bottom-up -- like Lego blocks -- to destroy bacteria," said Assistant Professor Cheemeng Tan, who led the work. The cells are built from liposomes, or bubbles with a cell-like lipid membrane, and purified cellular components including proteins, DNA and metabolites.

"We demonstrated that artificial cells can sense, react and interact with bacteria, as well as function as systems that both detect and kill bacteria with little dependence on their environment," Tan said.

The team's artificial cells mimic the essential features of live cells, but are short-lived and cannot divide to reproduce themselves. The cells were designed to respond to a unique chemical signature on E. coli bacteria. They were able to detect, attack and destroy the bacteria in laboratory experiments.

Artificial cells previously only had been successful in nutrient-rich environments, Tan said. However, by optimizing the artificial cells' membranes, cytosol and genetic circuits, the team made them work in a wide variety of environments with very limited resources such as water, emphasizing their robustness in less-than-ideal or changing conditions. These improvements significantly broaden the overall potential application of artificial cells.

Antibacterial artificial cells might one day be infused into patients to tackle infections resistant to other treatments. They might also be used to deliver drugs at the specific location and time, or as biosensors.

Coauthors on the paper are Yunfeng Ding, Eliza Morris, Luis Contreras-Llano and Michelle Mao. The work was supported by NSF, a Branco-Weiss Fellowship to Tan and by a UC MEXUS-CONACYT Doctoral Fellowship to Contreras-Llano.

Story Source:

Materials provided by **University of California - Davis**. *Note: Content may be edited for style and length.*

Falling stars hold clue for understanding dying stars -- ScienceDaily

An international team of researchers has proposed a new method to investigate the inner workings of supernovae explosions. This new method uses meteorites and is unique in that it can determine the contribution from electron anti-neutrinos, enigmatic particles which can't be tracked through other means.

Supernovae are important events in the evolution of stars and galaxies, but the details of how the explosions occur are still unknown. This research, led by Takehito Hayakawa, a visiting professor at the National Astronomical Observatory of Japan, found a method to investigate the role of electron anti-neutrinos in supernovae. By measuring the amount of 98Ru (an isotope of Ruthenium) in meteorites, it should be possible to estimate how much of its progenitor 98Tc (a short-lived isotope of Technetium) was present in the material from which the Solar System formed. The amount of 98Tc in turn is sensitive to the characteristics, such as temperature, of electron anti-neutrinos in the supernova process; as well as to how much time passed between the supernova and the formation of the Solar System. The expected traces of 98Tc are only a little below the smallest currently detectable levels, raising hopes that they will be measured in the near future.

Hayakawa explains, "There are six neutrino species. Previous studies have shown that neutrino-isotopes are predominantly produced by the five neutrino species other than the electron anti-neutrino. By finding a neutrino-isotope synthesized predominantly by the electron anti-neutrino, we can estimate the temperatures of all six neutrino species, which are important for understanding the supernova explosion mechanism."

At the end of its life, a massive star dies in a fiery explosion known as a supernova. This explosion blasts most of the mass in the star out into outer space. That mass is then recycled into new stars and planets, leaving distinct chemical signatures which tell scientists about the supernova. Meteorites,

sometimes called falling stars, formed from material left over from the birth of the Solar System, thus preserving the original chemical signatures.

Story Source:

Materials provided by **National Institutes of Natural Sciences**. *Note: Content may be edited for style and length.*

Tracking marine migrations across geopolitical boundaries aids conservation -- ScienceDaily

The leatherback sea turtle is the largest living turtle and a critically endangered species. Saving leatherback turtles from extinction in the Pacific Ocean will require a lot of international cooperation, however, because the massive turtles may visit more than 30 different countries during their migrations.

A new study uses tracking data for 14 species of migratory marine predators, from leatherback turtles to blue whales and white sharks, to show how their movements relate to the geopolitical boundaries of the Pacific Ocean. The results provide critical information for designing international cooperative agreements needed to manage these species.

"If a species spends most of its time in the jurisdiction of one or two countries, conservation and management is a much easier issue than it is for species that migrate through many different countries," said Daniel Costa, professor of ecology and evolutionary biology at UC Santa Cruz and a coauthor of the study, published September 3 in *Nature Ecology & Evolution*.

"For these highly migratory species, we wanted to know how many jurisdictional regions they go through and how much time they spend in the open ocean beyond the jurisdiction of any one country," Costa said.

Under international law, every coastal nation can establish an exclusive economic zone (EEZ) extending up to 200 nautical miles from shore, giving it exclusive rights to exploit resources and regulate fisheries within that zone. The high seas beyond the EEZs are a global commons and are among the least protected areas on Earth. Discussions have been under way at the United Nations since 2016 to negotiate a global treaty for conservation and management of the high seas.

First author Autumn-Lynn Harrison, now at the Smithsonian Conservation Biology Institute in Washington, D.C., began the study as a graduate student in Costa's lab at UC Santa Cruz. Costa is a cofounder, with coauthor Barbara Block of Stanford University, of the Tagging of Pacific Predators (TOPP) program, which began tracking the movements of top ocean predators throughout the Pacific Ocean in 2000. Harrison wanted to use the TOPP data to address conservation issues, and as she looked at the data she began wondering how many countries the animals migrate through.

"I wanted to see if we could predict when during the year a species would be in the waters of a particular country," Harrison said. "Some of these animals are mostly hidden beneath the sea, so being able to show with tracking data which countries they are in can help us understand who should be cooperating to manage these species."

Harrison also began attending meetings on issues related to the high seas, which focused her attention on the time migratory species spend in these relatively unregulated waters. "Figuring out how much time these animals spend in the high seas was directly motivated by questions I was being asked by policy makers who are interested in high seas conservation," she said.

The TOPP data set, part of the global Census of Marine Life, is one of the most extensive data sets available on the movements of large marine animals. Many of the top predators in the oceans are declining or threatened, partly because their mobility exposes them to a wide array of threats in different parts of the ocean.

Leatherback turtle populations in the Pacific could face a 96 percent decline by 2040, according to the IUCN Red List of Threatened Species, and leatherbacks are a priority species for the National Oceanic and Atmospheric Administration (NOAA). Laysan and black-footed albatrosses, both listed as near threatened on the IUCN Red List, spend most of their time on the high seas, where they are vulnerable to being inadvertently caught on long lines during commercial fishing operations.

White sharks are protected in U.S. and Mexican waters, but the TOPP data show that they spend about 60 percent of their time in the high seas. Pacific bluefin tuna, leatherback turtles, Laysan albatross, and sooty shearwaters all

travel across the Pacific Ocean during their migrations.

"Bluefin tuna breed in the western North Pacific, then cross the Pacific Ocean to feed in the California Current off the United States and Mexico," Costa said. "Sooty shearwaters not only cross the open ocean, they use the entire Pacific Ocean from north to south and go through the jurisdictions of more than 30 different countries."

International cooperation has led to agreements for managing some of these migratory species, in some cases through regional fisheries management organizations. The Inter-American Tropical Tuna Commission (IATTC), for example, oversees conservation and management of tunas and other marine resources in the eastern Pacific Ocean.

The first session of a U.N. Intergovernmental Conference to negotiate an international agreement on the conservation of marine biological diversity beyond areas of national jurisdiction will be held in September. Harrison said she has already been asked to provide preprints and figures from the paper for this session.

"These migratory species are a shared heritage, and this paper shows their international travels better than ever before," Harrison said. "The first step to protect them is knowing where they are over their annual cycle and promoting international agreements to manage the threats they may face across several countries."

Scientists pioneer a new way to turn sunlight into fuel: New research in the field of semi-artificial photosynthesis -- ScienceDaily

The quest to find new ways to harness solar power has taken a step forward after researchers successfully split water into hydrogen and oxygen by altering the photosynthetic machinery in plants.

Photosynthesis is the process plants use to convert sunlight into energy. Oxygen is produced as by-product of photosynthesis when the water absorbed by plants is 'split'. It is one of the most important reactions on the planet because it is the source of nearly all of the world's oxygen. Hydrogen which is produced when the water is split could potentially be a green and unlimited source of renewable energy.

A new study, led by academics at St John's College, University of Cambridge, used semi-artificial photosynthesis to explore new ways to produce and store solar energy. They used natural sunlight to convert water into hydrogen and oxygen using a mixture of biological components and humanmade technologies.

The research could now be used to revolutionise the systems used for renewable energy production. A new paper, published in *Nature Energy*, outlines how academics at the Reisner Laboratory in Cambridge developed their platform to achieve unassisted solar-driven water-splitting.

Their method also managed to absorb more solar light than natural photosynthesis.

Katarzyna Sokól, first author and PhD student at St John's College, said: "Natural photosynthesis is not efficient because it has evolved merely to survive so it makes the bare minimum amount of energy needed -- around 1-2

per cent of what it could potentially convert and store."

Artificial photosynthesis has been around for decades but it has not yet been successfully used to create renewable energy because it relies on the use of catalysts, which are often expensive and toxic. This means it can't yet be used to scale up findings to an industrial level.

The Cambridge research is part of the emerging field of semi-artificial photosynthesis which aims to overcome the limitations of fully artificial photosynthesis by using enzymes to create the desired reaction.

Sokól and the team of researchers not only improved on the amount of energy produced and stored, they managed to reactivate a process in the algae that has been dormant for millennia.

She explained: "Hydrogenase is an enzyme present in algae that is capable of reducing protons into hydrogen. During evolution this process has been deactivated because it wasn't necessary for survival but we successfully managed to bypass the inactivity to achieve the reaction we wanted -- splitting water into hydrogen and oxygen."

Sokól hopes the findings will enable new innovative model systems for solar energy conversion to be developed.

She added: "It's exciting that we can selectively choose the processes we want, and achieve the reaction we want which is inaccessible in nature. This could be a great platform for developing solar technologies. The approach could be used to couple other reactions together to see what can be done, learn from these reactions and then build synthetic, more robust pieces of solar energy technology."

This model is the first to successfully use hydrogenase and photosystem II to create semi-artificial photosynthesis driven purely by solar power.

Dr Erwin Reisner, Head of the Reisner Laboratory, a Fellow of St John's College, University of Cambridge, and one of the paper's authors described the research as a 'milestone'.

He explained: ""This work overcomes many difficult challenges associated with the integration of biological and organic components into inorganic materials for the assembly of semi-artificial devices and opens up a toolbox for developing future systems for solar energy conversion."

Story Source:

Mud from the deep sea reveals clues about ancient monsoon -- ScienceDaily

Analyzing traces of leaf waxes from land plants that over millennia accumulated in deep sea sediments, a team of researchers led by the University of Arizona reconstructed the history of monsoon activity in northern Mexico. Their results, published online on Sept. 3 in the journal *Nature Geoscience*, help settle a long-standing debate over whether monsoon activity shut down completely under the influence of cooling brought about by the ice sheets that covered much of North America, or was merely suppressed.

During the Last Glacial Maximum, about 20,000 years ago, when mammoths and other prehistoric beasts roamed what is now northern Mexico and the southwestern United States, summer rains contributed a 35 percent of the annual rainfall, compared with about 70 percent today, according to the new study.

By diverting moisture from the tropics, the summer monsoon brings relief from months-long intense summer heat and drought to the arid lands of the American Southwest and northwestern Mexico. If the region depended on winter rains alone, the Sonoran Desert would not be known as one of the world's most biodiverse deserts.

"The monsoon is such an iconic feature of the desert Southwest, but we know very little about how it has changed over thousands and millions of years," says Tripti Bhattacharya, the study's first author. "Our finding that the Southwestern monsoon was suppressed, but not completely gone under glacial conditions, points to the dramatic variability of the atmospheric circulation at the time, but suggests it has been a persistent feature of our regional climate."

Previous studies had yielded inconclusive results, in part because the records used to infer evidence of past monsoon rainfall tend to be more like snapshots

in time rather than providing more continuous climate records. For example, researchers have gained valuable glimpses into long-vanished plant communities based on plant parts preserved in packrat nests called middens, or by analyzing the chemical signatures they left behind in soils. Those studies suggested persistent monsoon activity during the last ice age, whereas other studies based on climate modeling indicated it was temporarily absent.

By applying a clever method never before used to study the history of the monsoon, Bhattacharya and her co-authors discovered the equivalent of a forgotten, unopened book of past climate records, as opposed to previously studied climate archives, which in comparison are more like single, scattered pages.

Forming a vast natural vault almost 1,000 meters below the sea surface, the seafloor of oxygen-poor zones in the Gulf of California contains organic material blown into the water for many thousands of years, including debris from land plants growing in the region. Since the deposits remain largely undisturbed from scavengers or microbial activity, Tierney and her team were able to isolate leaf wax compounds from the seafloor mud.

Co-author Jessica Tierney, an associate professor in the UA's Department of Geosciences and Bhattacharya's former postdoctoral adviser, has pioneered the analysis of the waxy coatings of plant leaves to reconstruct rainfall or dry spells in the past based on their chemical fingerprint, specifically different ratios of hydrogen atoms. The water in monsoon rain, according to Tierney, contains a larger proportion of a hydrogen isotope known as deuterium, or "heavy water," which has to do with its origin in the tropics. Winter rains, on the other hand, carry a different signature because they contain water with a smaller ratio of deuterium versus "regular" hydrogen.

"Plants take up whichever water they get, and because the two seasons have different ratios of hydrogen isotopes, we can relate the isotope ratios in the preserved leaf waxes to the amount of monsoon rain across the Gulf of California region," Tierney explains.

Piecing together past patterns of the monsoon in the Southwest can help scientists better predict future scenarios under the influence of a climate that's trending toward a warmer world, not another ice age, the researchers say.

"The past is not a perfect analog, but it acts as a natural experiment that helps us test how well we understand the variability of regional climate," says Bhattacharya, who recently accepted a position as assistant professor of earth sciences at Syracuse University. "If we understand how regional climates responded in the past, it gives us a much better shot at predicting how they will respond to climate change in the future."

One way scientists can take advantage of past climate records is by applying climate models to them, using the records to "ground-truth" the models.

"The problem is that right now, our best climate models don't agree with regard to how the monsoon will change in response to global warming," Tierney says. "Some suggest the summer precipitation will become stronger, others say it'll get weaker. By better understanding the mechanics of the phenomenon, our results can help us figure out why the models disagree and provide constraints that can translate into the future."

To test the hypothesis of whether colder times generally weaken the monsoon and warmer periods strengthen it, Tierney's group is planning to investigate how the monsoon responded to warmer periods in the past. Future research will focus on the last interglacial period about 120,000 years ago, and a period marked by greenhouse gas levels similar to those in today's atmosphere: the Pliocene Epoch, which lasted from 5.3-2.5 million years ago.

Having better records of the Southwestern monsoon also helps scientists better understand how it compares to monsoons in other parts of the world that are better studied.

"We now know that our monsoon appears to be much more sensitive to the large-scale configuration of the atmosphere, whereas other monsoon systems are tied more closely to local ocean conditions," Bhattacharya says.

Little star sheds light on young planets: Astronomers discover new stage in evolution of young solar systems -- ScienceDaily

Early in 2017, Assistant Professor Yoko Oya gave graduate student Yuki Okoda some recent complex data on a nearby star with which she could begin her Ph.D. Little did she realize that what she would find could unlock not only the secrets of how planets form but possibly her career as a professional astronomer.

The star in question (only known by its catalog number IRAS 15398-3359) is small, young and relatively cool for a star. It's diminutive stature means the weak light it shines can't even reach us through a cloud of gas and dust that surrounds it. But this doesn't stop inquisitive minds from exploring the unknown.

In 2013, Oya and her collaborators used the Atacama Large Millimeter/submillimeter Array (ALMA) in Chile to observe the star in submillimeter wavelengths, as that kind of light can penetrate the dust cloud -- for reference, red light is around 700 nanometers. A painstaking analysis revealed some interesting nebulous structures, despite the images they worked from being difficult to comprehend.

"The greatest academic challenge I've faced was trying to make sense of grainy images. It's extremely difficult to know exactly what you're really looking at." says Okoda. "But I felt compelled to explore the nature of the structures Dr. Oya had seen with ALMA, so I came up with a model to explain them." The model she produced came as a surprise to Okoda and her colleagues, but it fit the data perfectly. It describes a dense disk of material that consists of gas and dust from the cloud that surrounds the star. This has never before been seen around such a young star.

The disk is a precursor to a protoplanetary disk, which is far denser still and eventually becomes a planetary system in orbit around a star.

"We can't say for sure this particular disk will coalesce into a new planetary system," explains Oya. "The dust cloud may be pushed away by stellar winds or it might all fall into the star itself, feeding it in the process. What's exciting is how quickly this might happen."

The star is small at around 0.7 percent the mass of our sun, based on observations of the mass of the surrounding cloud. It could grow to as large as 20 percent in just a few tens of thousands of years, a blink of the eye on the cosmic scale.

"I hope our observations and models will enhance knowledge of how solar systems form," says Okoda. "My research interests involve young protostellar objects, and the implication that protoplanetary disks could form earlier than expected really excites me."

Okoda began this project a year-and-a-half ago to hone her skills as an astronomer, but mirroring the young star she observed, the practice evolved quickly and became a full research project, which will hopefully earn her a Ph.D. from the University of Tokyo.

The observations and resultant model were only possible thanks to advancements in radio astronomy with observatories such as ALMA. The team was lucky that the plane of the disk is level with our own solar system as this means the starlight ALMA sees passes through enough of the gas and dust to divulge important characteristics of it.

"We were also lucky to be given time with ALMA to carry out our observations. Only about 20 percent of applications actually go ahead," explains Oya. "With highly specialized astronomical instruments, there is much competition for time. My hope is our success will inspire a new generation of astronomers in Japan to reach for the stars."

Story Source:

Materials provided by **University of Tokyo**. *Note: Content may be edited for*

style and length.

8,000 new antibiotic combinations are surprisingly effective: Grouping 4 or 5 existing medications could help slow antibiotic-resistant bacteria -- ScienceDaily

Scientists have traditionally believed that combining more than two drugs to fight harmful bacteria would yield diminishing returns. The prevailing theory is that that the incremental benefits of combining three or more drugs would be too small to matter, or that the interactions among the drugs would cause their benefits to cancel one another out.

Now, a team of UCLA biologists has discovered thousands of four- and five-drug combinations of antibiotics that are more effective at killing harmful bacteria than the prevailing views suggested. Their findings, reported today in the journal *npj Systems Biology and Applications*, could be a major step toward protecting public health at a time when pathogens and common infections are increasingly becoming resistant to antibiotics.

"There is a tradition of using just one drug, maybe two," said Pamela Yeh, one of the study's senior authors and a UCLA assistant professor of ecology and evolutionary biology. "We're offering an alternative that looks very promising. We shouldn't limit ourselves to just single drugs or two-drug combinations in our medical toolbox. We expect several of these combinations, or more, will work much better than existing antibiotics."

Working with eight antibiotics, the researchers analyzed how every possible four- and five-drug combination, including many with varying dosages -- a total of 18,278 combinations in all -- worked against *E. coli*. They expected that some of the combinations would be very effective at killing the bacteria, but they were startled by how many potent combinations they discovered.

For every combination they tested, the researchers first predicted how

effective they thought it would be in stopping the growth of *E. coli*. Among the four-drug combinations, there were 1,676 groupings that performed better than they expected. Among the five-drug combinations, 6,443 groupings were more effective than expected.

"I was blown away by how many effective combinations there are as we increased the number of drugs," said Van Savage, the study's other senior author and a UCLA professor of ecology and evolutionary biology and of biomathematics. "People may think they know how drug combinations will interact, but they really don't."

On the other hand, 2,331 four-drug combinations and 5,199 five-drug combinations were less effective than the researchers expected they would be, said Elif Tekin, the study's lead author, who was a UCLA postdoctoral scholar during the research.

Some of the four- and five-drug combinations were effective at least partly because individual medications have different mechanisms for targeting *E. coli*. The eight tested by the UCLA researchers work in six unique ways.

"Some drugs attack the cell walls, others attack the DNA inside," Savage said. "It's like attacking a castle or fortress. Combining different methods of attacking may be more effective than just a single approach."

Said Yeh: "A whole can be much more, or much less, than the sum of its parts, as we often see with a baseball or basketball team." (As an example, she cited the decisive upset victory in the 2004 NBA championship of the Detroit Pistons -- a cohesive team with no superstars -- over a Los Angeles Lakers team with future Hall of Famers Kobe Bryant, Shaquille O'Neal, Karl Malone and Gary Payton.)

Yeh added that although the results are very promising, the drug combinations have been tested in only a laboratory setting and likely are at least years away from being evaluated as possible treatments for people.

"With the specter of antibiotic resistance threatening to turn back health care to the pre-antibiotic era, the ability to more judiciously use combinations of existing antibiotics that singly are losing potency is welcome," said Michael

Kurilla, director of the Division of Clinical Innovation at the National Institutes of Health/National Center for Advancing Translational Sciences. "This work will accelerate the testing in humans of promising antibiotic combinations for bacterial infections that we are ill-equipped to deal with today."

The researchers are creating open-access software based on their work that they plan to make available to other scientists next year. The software will enable other researchers to analyze the different combinations of antibiotics studied by the UCLA biologists, and to input data from their own tests of drug combinations.

Using a MAGIC framework

One component of the software is a mathematical formula for analyzing how multiple factors interact, which the UCLA scientists developed as part of their research. They call the framework "mathematical analysis for general interactions of components," or MAGIC.

"We think MAGIC is a generalizable tool that can be applied to other diseases -- including cancers -- and in many other areas with three or more interacting components, to better understand how a complex system works," Tekin said.

Savage said he plans to use concepts from that framework in his ongoing research on how temperature, rain, light and other factors affect the Amazon rainforests.

He, Yeh and Mirta Galesic, a professor of human social dynamics at the Santa Fe Institute, also are using MAGIC in a study of how people's formation of ideas is influenced by their parents, friends, schools, media and other institutions -- and how those factors interact.

"It fits in perfectly with our interest in interacting components," Yeh said.

Other co-authors of the new study are Cynthia White, a UCLA graduate who was a research technician while working on the project; Tina Kang, a UCLA doctoral student; Nina Singh, a student at the University of Southern

California; Mauricio Cruz-Loya, a UCLA doctoral student; and Robert Damoiseaux, professor of molecular and medical pharmacology, and director of UCLA's Molecular Screening Shared Resource, a facility with advanced robotics technology where Tekin, White, and Kang conducted much of the research.

The research team reported in 2016 that combinations of three antibiotics can often overcome bacteria's resistance to antibiotics, even when none of the three antibiotics on its own -- or even two of the three together -- is effective. The biologists reported in 2017 two combinations of drugs that are unexpectedly successful in reducing the growth of *E. coli* bacteria.

A new way to remove ice buildup without power or chemicals: Passive solar-powered system could prevent freezing on airplanes, wind turbines, powerlines, and other surfaces -- ScienceDaily

From airplane wings to overhead powerlines to the giant blades of wind turbines, a buildup of ice can cause problems ranging from impaired performance all the way to catastrophic failure. But preventing that buildup usually requires energy-intensive heating systems or chemical sprays that are environmentally harmful. Now, MIT researchers have developed a completely passive, solar-powered way of combating ice buildup.

The system is remarkably simple, based on a three-layered material that can be applied or even sprayed onto the surfaces to be treated. It collects solar radiation, converts it to heat, and spreads that heat around so that the melting is not just confined to the areas exposed directly to the sunlight. And, once applied, it requires no further action or power source. It can even do its de-icing work at night, using artificial lighting.

The new system is described today in the journal *Science Advances*, in a paper by MIT associate professor of mechanical engineering Kripa Varanasi and postdocs Susmita Dash and Jolet de Ruiter.

"Icing is a major problem for aircraft, for wind turbines, powerlines, offshore oil platforms, and many other places," Varanasi says. "The conventional ways of getting around it are de-icing sprays or by heating, but those have issues."

Inspired by the sun

The usual de-icing sprays for aircraft and other applications use ethylene

glycol, a chemical that is environmentally unfriendly. Airlines don't like to use active heating, both for cost and safety reasons. Varanasi and other researchers have investigated the use of superhydrophobic surfaces to prevent icing passively, but those coatings can be impaired by frost formation, which tends to fill the microscopic textures that give the surface its ice-shedding properties.

As an alternate line of inquiry, Varanasi and his team considered the energy given off by the sun. They wanted to see, he says, whether "there is a way to capture that heat and use it in a passive approach." They found that there was.

It's not necessary to produce enough heat to melt the bulk of the ice that forms, the team found. All that's needed is for the boundary layer, right where the ice meets the surface, to melt enough to create a thin layer of water, which will make the surface slippery enough so any ice will just slide right off. This is what the team has achieved with the three-layered material they've developed.

Layer by layer

The top layer is an absorber, which traps incoming sunlight and converts it to heat. The material the team used is highly efficient, absorbing 95 percent of the incident sunlight, and losing only 3 percent to re-radiation, Varanasi says

In principle, that layer could in itself help to prevent frost formation, but with two limitations: It would only work in the areas directly in sunlight, and much of the heat would be lost back into the substrate material -- the airplane wing or powerline, for example -- and would not help with the de-icing.

So, to compensate for the localization, the team added a spreader layer -- a very thin layer of aluminum, just 400 micrometers thick, which is heated by the absorber layer above it and very efficiently spreads that heat out laterally to cover the entire surface. The material was selected to have "thermal response that is fast enough so that the heating takes place faster than the freezing," Varanasi says.

Finally, the bottom layer is simply foam insulation, to keep any of that heat from being wasted downward and keep it where it's needed, at the surface.

"In addition to passive de-icing, the photothermal trap stays at an elevated temperature, thus preventing ice build-up altogether," Dash says.

The three layers, all made of inexpensive commercially available material, are then bonded together, and can be bonded to the surface that needs to be protected. For some applications, the materials could instead be sprayed onto a surface, one layer at a time, the researchers say.

The team carried out extensive tests, including real-world outdoor testing of the materials and detailed laboratory measurements, to prove the effectiveness of the system.

The system could even find wider commercial uses, such as panels to prevent icing on roofs of homes, schools, and other buildings, Varanasi says. The team is planning to continue work on the system, testing it for longevity and for optimal methods of application. But the basic system could essentially be applied almost immediately for some uses, especially stationary applications, he says.

Sound can be used to print droplets that couldn't be printed before -- ScienceDaily

Harvard University researchers have developed a new printing method that uses sound waves to generate droplets from liquids with an unprecedented range of composition and viscosity. This technique could finally enable the manufacturing of many new biopharmaceuticals, cosmetics, and food and expand the possibilities of optical and conductive materials.

"By harnessing acoustic forces, we have created a new technology that enables myriad materials to be printed in a drop-on-demand manner," said Jennifer Lewis, the Hansjorg Wyss Professor of Biologically Inspired Engineering at the Harvard John A. Paulson School of Engineering and Applied Sciences and the senior author of the paper.

Lewis is also a Core Faculty Member at the Wyss Institute for Biologically Inspired Engineering and the Jianming Yu Professor of Arts and Sciences at Harvard.

The research is published in *Science Advances*.

Liquid droplets are used in many applications from printing ink on paper to creating microcapsules for drug delivery. Inkjet printing is the most common technique used to pattern liquid droplets, but it's only suitable for liquids that are roughly 10 times more viscous than water. Yet many fluids of interest to researchers are far more viscous. For example, biopolymer and cell-laden solutions, which are vital for biopharmaceuticals and bioprinting, are at least 100 times more viscous than water. Some sugar-based biopolymers could be as viscous as honey, which is 25,000 times more viscous than water.

The viscosity of these fluids also changes dramatically with temperature and composition, makes it even more difficult to optimize printing parameters to control droplet sizes.

"Our goal was to take viscosity out of the picture by developing a printing system that is independent from the material properties of the fluid," said Daniele Foresti, first author of the paper, the Branco Weiss Fellow and Research Associate in Materials Science and Mechanical Engineering at SEAS and the Wyss Institute.

To do that, the researchers turned to acoustic waves.

Thanks to gravity, any liquid can drip -- from water dripping out of a faucet to the century-long pitch drop experiment. With gravity alone, droplet size remains large and drop rate difficult to control. Pitch, which has a viscosity roughly 200 billion times that of water, forms a single drop per decade.

To enhance drop formation, the research team relies on generating sound waves. These pressure waves have been typically used to defy gravity, as in the case of acoustic levitation. Now, the researchers are using them to assist gravity, dubbing this new technique acoustophoretic printing.

The researchers built a subwavelength acoustic resonator that can generate a highly confined acoustic field resulting in a pulling force exceeding 100 times the normal gravitation forces (1 G) at the tip of the printer nozzle -- that's more than four times the gravitational force on the surface of the sun.

This controllable force pulls each droplet off of the nozzle when it reaches a specific size and ejects it towards the printing target. The higher the amplitude of the sound waves, the smaller the droplet size, irrespective of the viscosity of the fluid.

"The idea is to generate an acoustic field that literally detaches tiny droplets from the nozzle, much like picking apples from a tree," said Foresti.

The researchers tested the process on a wide range of materials from honey to stem-cell inks, biopolymers, optical resins and, even, liquid metals. Importantly, sound waves don't travel through the droplet, making the method safe to use even with sensitive biological cargo, such as living cells or proteins.

"Our technology should have an immediate impact on the pharmaceutical

industry," said Lewis. "However, we believe that this will become an important platform for multiple industries."

"This is an exquisite and impactful example of the breadth and reach of collaborative research," said Dan Finotello, director of NSF's MRSEC program. "The authors have developed a new printing platform using acoustic-forces, which, unlike in other methods, are material-independent and thus offer tremendous printing versatility. The application space is limitless."

The Harvard Office of Technology Development has protected the intellectual property relating to this project and is exploring commercialization opportunities.

This research was co-authored by Katharina Kroll, Robert Amissah, Francesco Sillani, Kimberly Homan and Dimos Poulikakos. It was funded by Society in Science through the Branco Weiss Fellowship and the National Science Foundation through Harvard MRSEC.

Video: https://www.youtube.com/watch?v=FCbxfe9F6fs

Eating in 10-hour window can override disease-causing genetic defects, nurture health: Periods of fasting can protect against obesity and diabetes -- ScienceDaily

Scientists at the Salk Institute found that mice lacking the biological clocks thought to be necessary for a healthy metabolism could still be protected against obesity and metabolic diseases by having their daily access to food restricted to a 10-hour window.

The work, which appeared in the journal *Cell Metabolism* on August 30, 2018, suggests that the health problems associated with disruptions to animals' 24-hour rhythms of activity and rest -- which in humans is linked to eating for most of the day or doing shift work -- can be corrected by eating all calories within a 10-hour window.

"For many of us, the day begins with a cup of coffee first thing in the morning and ends with a bedtime snack 14 or 15 hours later," says Satchidananda Panda, a professor in Salk's Regulatory Biology Laboratory and the senior author of the new paper. "But restricting food intake to 10 hours a day, and fasting the rest, can lead to better health, regardless of our biological clock."

Every cell in mammals' bodies operates on a 24-hour cycle known as the circadian rhythm -- cellular cycles that govern when various genes are active. For example, in humans, genes for digestion are more active earlier in the day while genes for cellular repair are more active at night. Previously, the Panda lab discovered that mice allowed 24-hour access to a high-fat diet became obese and developed a slew of metabolic diseases including high cholesterol, fatty liver and diabetes. But these same mice, when restricted to the high-fat diet for a daily 8- to 10-hour window became lean, fit and healthy. The lab attributed the health benefits to keeping the mice in better sync with their

cellular clocks -- for example, by eating most of the calories when genes for digestion were more active.

In the current study, the team aimed to better understand the role of circadian rhythms in metabolic diseases by disabling genes responsible for maintaining the biological clock in mice, including in the liver, which regulates many metabolic functions. The genetic defects in these clock-less mice make them prone to obesity, diabetes, fatty liver disease and elevated blood cholesterol. These diseases further escalate when the animals are allowed to eat fatty and sugary food.

To test whether time-restricted eating could benefit these "clock-less" mice, Panda's team put them on one of two high-fat diet regimes: one group had access to food around the clock, the other had access to the same number of calories only during a 10-hour window. As the team expected, the group that could eat at any time became obese and developed metabolic diseases. But the group that ate the same number of calories within a 10-hour window remained lean and healthy -- despite not having an internal "biological clock" and thereby genetically programmed to be morbidly sick. This told the researchers that the health benefits from a 10-hour window were not just due to restricting eating to times when genes for digestion were more active.

"From the previous study, we had been under the impression that the biological clock was internally timing the process of turning genes for metabolism on and off at predetermined times," says Amandine Chaix, a staff scientist at Salk and the paper's first author. "And while that may still be true, this work suggests that by controlling the animals' feeding and fasting cycles, we can basically override the lack of an internal timing system with an external timing system."

According to the researchers, the new work suggests that the primary role of circadian clocks may be to tell the animal when to eat and when to stay away from food. This internal timing strikes a balance between sufficient nutrition during the fed state and necessary repair or rejuvenation during fasting. When this circadian clock is disrupted, as when humans do shift work, or when it is compromised due to genetic defects, the balance between nutrition and rejuvenation breaks down and diseases set in.

As we age, our circadian clocks weaken. This age-dependent deterioration of circadian clock parallels our increased risk for metabolic diseases, heart diseases, cancer and dementia.

But the good news, say the researchers, is that a simple lifestyle such as eating all food within 10 hours can restore balance, stave off metabolic diseases and maintain health. "Many of us may have one or more disease-causing defective genes that make us feel helpless and destined to be sick. The finding that a good lifestyle can beat the bad effects of defective genes opens new hope to stay healthy," says Panda.

The lab next plans to study whether eating within 8-10 hours can prevent or reverse many diseases of aging, as well as looking at how the current study could apply to humans. Their website, mycircadianclock.org, allows people anywhere in the world to sign up for studies, download an app and get guidance on how to adopt an optimum daily eating-fasting cycle. By collecting daily eating and health status data from thousands of people, the lab hopes to gain a better understanding of how a daily eating-fasting cycle sustains health.

Story Source:

Materials provided by **Salk Institute**. *Note: Content may be edited for style and length.*

Are vulnerable lions eating endangered zebras? New study looks at whether a recovering predator is causing another species to decline -- ScienceDaily

That's what a team of researchers led by WCS and WWF set out to discover -- whether the comeback of a top predator -- in this case lions in Laikipa County, Kenya -- were recovering at the expense of Grevy's zebras, which number only around 2,680 individuals with half of those living in Likipia.

In recent years, lion numbers have slowly recovered in this region as livestock ranching -- which commonly practiced shooting or poisoning lions -- has given way to wildlife tourism. Lions (*Panthera leo*) are classified as Threatened by IUCN.

Publishing their results in the journal *PLOS ONE*, the team used satellite telemetry to track the movements of both lions and zebras.

The team found that lions preyed on both Grevy's and plains zebras (*Equus quagga*) far less than expected. Their data showed that the population of Grevy's zebra populations may in fact be stabilizing with recruitment into the population tripling since 2004.

The researchers did conclude that competitive displacement by livestock and interference competition for grass from plains zebras, which are 22 times more abundant than Grevy's, are most likely the predominant threat to Grevy's zebras' recovery.

Story Source:

Materials provided by **Wildlife Conservation Society**. *Note: Content may be edited for style and length.*

Synthetic microbiome? Genetic engineering allows different species of bacteria to communicate -- ScienceDaily

More than 1,000 species of bacteria have been identified in the human gut, and understanding this incredibly diverse "microbiome" that can greatly impact health and disease is a hot topic in scientific research. Because bacteria are routinely genetically engineered in science labs, there is great excitement about the possibility of tweaking the genes of our intestinal interlopers so that they can do more than just help digest our food (e.g., record information about the state of the gut in real-time, report the presence of disease, etc.). However, little is known about how all those different strains communicate with each other, and whether it is even possible to create the kinds of signaling pathways that would allow information to be passed between them.

Now, researchers from the Wyss Institute at Harvard University, Harvard Medical School (HMS), and Brigham and Women's Hospital have successfully engineered a genetic signal-transmission system in which a molecular signal sent by Salmonella Typhimurium bacteria in response to an environmental cue can be received and recorded by *E. coli* in the gut of a mouse, bringing scientists a step closer to developing a "synthetic microbiome" composed of bacteria that are programmed to perform specific functions. The study is reported in *ACS Synthetic Biology*.

"In order to improve human health through engineered gut bacteria, we need to start figuring out how to make the bacteria communicate," said Suhyun Kim, a graduate student in the lab of Pamela Silver at the Wyss Institute and HMS, who is the first author of the paper. "We want to make sure that, as engineered probiotics develop, we have a means to coordinate and control them in harmony."

The team harnessed an ability that naturally occurs in some strains of bacteria

called "quorum sensing," in which the bacteria send and receive signal molecules that indicate the overall density of the bacterial colony and regulate the expression of many genes involved in group activities. A particular type of quorum sensing known as acyl-homoserine lactone (acyl-HSL) sensing has not yet been observed in the mammalian gut, so the team decided to see if they could repurpose its signaling system to create a bacterial information transfer system using genetic engineering.

The researchers introduced two new genetic circuits into different colonies of a strain of *E. coli* bacteria: a "signaler" circuit, and a "responder" circuit. The signaler circuit contains a single copy of a gene called luxI that is turned on by the molecule anhydrotetracycline (ATC) and produces a quorum-sensing signaling molecule. The responder circuit is structured such that when the signaling molecule binds to it, a gene called cro is activated to produce the protein Cro, which then turns on a "memory element" within the responder circuit. The memory element expresses two additional genes: LacZ and another copy of cro. The expression of LacZ causes the bacterium to turn blue if plated on a special agar, thus producing visual confirmation that the signal molecule has been received. The extra copy of cro forms a positive feedback loop that keeps the memory element on, ensuring that the bacterium continues to express LacZ over an extended period of time.

The researchers confirmed that this system works in vitro in both *E. coli* and *S. Typhimurium* bacteria, observing that the responder bacteria turned blue when ATC was added to the signaler bacteria. To see if it would work in vivo, they administered both signaler and responder *E. coli* bacteria to mice, and then gave the mice ATC in their drinking water for two days. When fecal samples from the mice were analyzed, over half of the mice displayed clear signs of 3OC6HSL signal transmission that persisted after two days on ATC.

"It was exciting and promising that our system, with single copy-based circuits, can create functional communication in the mouse gut," explained Kim. "Traditional genetic engineering introduces multiple copies of a gene of interest into the bacterial genome via plasmids, which places a high metabolic burden on the engineered bacteria and causes them to be easily outcompeted by other bacteria in the host."

Finally, the team repeated the in vivo experiment, but gave the mice signaler

S. Typhimurium bacteria and *E. coli* responder bacteria, to see if the signal could be transmitted across different species of bacteria within the mouse's gut. All mice displayed signs of signal transmission, confirming that the engineered circuits allowed communication between different species of bacteria in the complex environment of the mammalian gut.

The researchers hope to continue this line of inquiry by engineering more species of bacteria so that they can communicate, and by searching for and developing other signaling molecules that can be used to transmit information between them.

"Ultimately, we aim to create a synthetic microbiome with completely or mostly engineered bacteria species in our gut, each of which has a specialized function (e.g., detecting and curing disease, creating beneficial molecules, improving digestion, etc.) but also communicates with the others to ensure that they are all balanced for optimal human health," said corresponding author Silver, Ph.D., a Founding Core Faculty member of the Wyss Institute who is also the Elliot T. and Onie H. Adams Professor of Biochemistry and Systems Biology at HMS.

"The microbiome is the next frontier in medicine as well as wellness. Devising new technologies to engineer intestinal microbes for the better while appreciating that they function as part of a complex community, as was done here, represents a major step forward in this direction," said Wyss Founding Director Donald Ingber, M.D., Ph.D., who is also the Judah Folkman Professor of Vascular Biology at HMS and the Vascular Biology Program at Boston Children's Hospital, as well as Professor of Bioengineering at SEAS.

Water worlds could support life, study says: Scientists challenges idea that life requires 'Earth clone' -- ScienceDaily

The conditions for life surviving on planets entirely covered in water are more fluid than previously thought, opening up the possibility that water worlds could be habitable, according to a new paper from the University of Chicago and Pennsylvania State University.

The scientific community has largely assumed that planets covered in a deep ocean would not support the cycling of minerals and gases that keeps the climate stable on Earth, and thus wouldn't be friendly to life. But the study, published Aug. 30 in The *Astrophysical Journal*, found that ocean planets could stay in the "sweet spot" for habitability much longer than previously assumed. The authors based their findings on more than a thousand simulations.

"This really pushes back against the idea you need an Earth clone -- that is, a planet with some land and a shallow ocean," said Edwin Kite, assistant professor of geophysical sciences at UChicago and lead author of the study.

As telescopes get better, scientists are finding more and more planets orbiting stars in other solar systems. Such discoveries are resulting in new research into how life could potentially survive on other planets, some of which are very different from Earth -- some may be covered entirely in water hundreds of miles deep.

Because life needs an extended period to evolve, and because the light and heat on planets can change as their stars age, scientists usually look for planets that have both some water and some way to keep their climates stable over time. The primary method we know of is how Earth does it. Over long timescales, our planet cools itself by drawing down greenhouse gases into minerals and warms itself up by releasing them via volcanoes.

But this model doesn't work on a water world, with deep water covering the rock and suppressing volcanoes.

Kite, and Penn State coauthor Eric Ford, wanted to know if there was another way. They set up a simulation with thousands of randomly generated planets, and tracked the evolution of their climates over billions of years.

"The surprise was that many of them stay stable for more than a billion years, just by luck of the draw," Kite said. "Our best guess is that it's on the order of 10 percent of them."

These lucky planets sit in the right location around their stars. They happened to have the right amount of carbon present, and they don't have too many minerals and elements from the crust dissolved in the oceans that would pull carbon out of the atmosphere. They have enough water from the start, and they cycle carbon between the atmosphere and ocean only, which in the right concentrations is sufficient to keep things stable.

"How much time a planet has is basically dependent on carbon dioxide and how it's partitioned between the ocean, atmosphere and rocks in its early years," said Kite. "It does seem there is a way to keep a planet habitable long-term without the geochemical cycling we see on Earth."

The simulations assumed stars that are like our own, but the results are optimistic for red dwarf stars, too, Kite said. Planets in red dwarf systems are thought to be promising candidates for fostering life because these stars get brighter much more slowly than our sun -- giving life a much longer time period to get started. The same conditions modeled in this paper could be applied to planets around red dwarfs, they said: Theoretically, all you would need is the steady light of a star.

Story Source:

Materials provided by **University of Chicago**. *Note: Content may be edited for style and length.*

Scientists identify protein that may have existed when life began: The primordial peptide may have appeared 4 billion years ago -- ScienceDaily

How did life arise on Earth? Rutgers researchers have found among the first and perhaps only hard evidence that simple protein catalysts -- essential for cells, the building blocks of life, to function -- may have existed when life began.

Their study of a primordial peptide, or short protein, is published in the Journ*al of the American Chemical Society*.

In the late 1980s and early 1990s, the chemist Günter Wächtershäuser postulated that life began on iron- and sulfur-containing rocks in the ocean. Wächtershäuser and others predicted that short peptides would have bound metals and served as catalysts of life-producing chemistry, according to study co-author Vikas Nanda, an associate professor at Rutgers' Robert Wood Johnson Medical School.

Human DNA consists of genes that code for proteins that are a few hundred to a few thousand amino acids long. These complex proteins -- needed to make all living-things function properly -- are the result of billions of years of evolution. When life began, proteins were likely much simpler, perhaps just 10 to 20 amino acids long. With computer modeling, Rutgers scientists have been exploring what early peptides may have looked like and their possible chemical functions, according to Nanda.

The scientists used computers to model a short, 12-amino acid protein and tested it in the laboratory. This peptide has several impressive and important features. It contains only two types of amino acids (rather than the estimated 20 amino acids that synthesize millions of different proteins needed for

specific body functions), it is very short and it could have emerged spontaneously on the early Earth in the right conditions. The metal cluster at the core of this peptide resembles the structure and chemistry of iron-sulfur minerals that were abundant in early Earth oceans. The peptide can also charge and discharge electrons repeatedly without falling apart, according to Nanda, a resident faculty member at the Center for Advanced Technology and Medicine.

"Modern proteins called ferredoxins do this, shuttling electrons around the cell to promote metabolism," said senior author Professor Paul G. Falkowski, who leads Rutgers' Environmental Biophysics and Molecular Ecology Laboratory. "A primordial peptide like the one we studied may have served a similar function in the origins of life."

Falkowski is the principal investigator for a NASA-funded ENIGMA project led by Rutgers scientists that aims to understand how protein catalysts evolved at the start of life. Nanda leads one team that will characterize the full potential of the primordial peptide and continue to develop other molecules that may have played key roles in the origins of life.

With computers, Rutgers scientists have smashed and dissected nearly 10,000 proteins and pinpointed four "Legos of life" -- core chemical structures that can be stacked to form the innumerable proteins inside all organisms. The small primordial peptide may be a precursor to the longer Legos of life, and scientists can now run experiments on how such peptides may have functioned in early-life chemistry.

Study co-lead authors are John Dongun Kim, postdoctoral researcher, and graduate student Douglas H. Pike. Other authors include Alexei M. Tyryshkin and G.V.T. Swapna, staff scientists; Hagai Raanan, postdoctoral researcher; and Gaetano T. Montelione, Jerome and Lorraine Aresty Chair and distinguished professor in the Department of Molecular Biology and Biochemistry. He is also a resident faculty member at the Center for Advanced Technology and Medicine.

Story Source:

Materials provided by **Rutgers University**. *Note: Content may be edited for*

style and length.

Dual-layer solar cell sets record for efficiently generating power -- ScienceDaily

Materials scientists from the UCLA Samueli School of Engineering have developed a highly efficient thin-film solar cell that generates more energy from sunlight than typical solar panels, thanks to its double-layer design.

The device is made by spraying a thin layer of perovskite -- an inexpensive compound of lead and iodine that has been shown to be very efficient at capturing energy from sunlight -- onto a commercially available solar cell. The solar cell that forms the bottom layer of the device is made of a compound of copper, indium, gallium and selenide, or CIGS.

The team's new cell converts 22.4 percent of the incoming energy from the sun, a record in power conversion efficiency for a perovskite-CIGS tandem solar cell. The performance was confirmed in independent tests at the U.S. Department of Energy's National Renewable Energy Laboratory. (The previous record, set in 2015 by a group at IBM's Thomas J. Watson Research Center, was 10.9 percent.) The UCLA device's efficiency rate is similar to that of the poly-silicon solar cells that currently dominate the photovoltaics market.

The research, which was published today in *Science*, was led by Yang Yang, UCLA's Carol and Lawrence E. Tannas Jr. Professor of Materials Science.

"With our tandem solar cell design, we're drawing energy from two distinct parts of the solar spectrum over the same device area," Yang said. "This increases the amount of energy generated from sunlight compared to the CIGS layer alone."

Yang added that the technique of spraying on a layer of perovskite could be easily and inexpensively incorporated into existing solar-cell manufacturing processes.

The cell's CIGS base layer, which is about 2 microns (or two-thousandths of a millimeter) thick, absorbs sunlight and generates energy at a rate of 18.7 percent efficiency on its own, but adding the 1 micron-thick perovskite layer improves its efficiency -- much like how adding a turbocharger to a car engine can improve its performance. The two layers are joined by a nanoscale interface that the UCLA researchers designed; the interface helps give the device higher voltage, which increases the amount of power it can export.

And the entire assembly sits on a glass substrate that's about 2 millimeters thick.

"Our technology boosted the existing CIGS solar cell performance by nearly 20 percent from its original performance," Yang said. "That means a 20 percent reduction in energy costs."

He added that devices using the two-layer design could eventually approach 30 percent power conversion efficiency. That will be the research group's next goal.

The study's lead authors are Qifeng Han, a visiting research associate in Yang's laboratory, and Yao-Tsung Hsieh and Lei Meng, who both recently earned their doctorates at UCLA. The study's other authors are members of Yang's research group and researchers from Solar Frontier Corp.'s Atsugi Research Center in Japan.

The research was supported by the National Science Foundation and the Air Force Office of Scientific Research. Yang and his research group have been working on tandem solar cells for several years and their accomplishments include developing transparent tandem solar cells that could be used in windows.

Story Source:

Materials provided by **UCLA Samueli School of Engineering**. *Note: Content may be edited for style and length.*

Biomechanics of chewing depend more on animal size, not diet: Researchers subjected 3D-printed structures of the jaw joint of bears, wolves and other carnivorans to pressures of up to hundreds of pounds -- ScienceDaily

Chewing: We don't think about it, we just do it. But biologists don't know a lot about how chewing behavior leaves telltale signs on the underlying bones. To find out, researchers at the Jacobs School of Medicine and Biomedical Sciences at the University at Buffalo have been studying the jaw joints of carnivorans, the large mammalian order that includes dogs, cats and bears.

Last week, the scientists described results that they didn't expect to find. In the paper, published online on Aug. 24 in PLOS ONE, they reported that the jaw joint bone, the center around which chewing activity revolves (literally), appears to have evolved based more on an animal's size than what it eats.

While focused on carnivorans, the research may also provide some clues to how jaw joints function in general, including in humans and could improve the understanding of temporomandibular disorders (TMJ), which cause pain in the jaw joint and in the muscles that control the jaw.

"Even though it is clear that the carnivoran jaw joint is important for feeding, no one knew if jaw joint bone structure across species was related to the mechanical demands of feeding," explained M. Aleksander Wysocki, first author and a doctoral student in the new computational cell biology, anatomy and pathology graduate program in the Department of Pathology and Anatomical Sciences in the Jacobs School.

Wysocki and co-author Jack Tseng, PhD, assistant professor in the

Department of Pathology and Anatomical Sciences in the Jacobs School, took a multifaceted approach. They examined 40 different carnivoran species from bobcats to wolves, looking at the jaw joint bone called the mandibular condyle.

The jaw's pivot point

"The mandibular condyle is the pivot point of the jaw, it functions similarly to the way the bolt of a door hinge does," Wysocki said. "Studies have shown that this joint is loaded with force during chewing."

He noted that the team was especially interested in the intricate, spongey bone structures inside the jaw joint, also known as trabecular bone. "We thought that this part of the skull would be the best candidate for determining relationships between food type and anatomy."

For example, because hyenas crush bone while consuming their prey, it could be assumed that their jaw joints would need to be capable of exerting significant force. "On the other hand, an animal that eats plants wouldn't be expected to require that kind of jaw joint structure," he said. "But we found that diet has a weaker relationship with skull anatomy than we thought. Mostly it's the animals' size that determines jaw joint structure and mechanical properties."

The researchers took computed tomography (CT) scan data of skulls from 40 species at the American Museum of Natural History, then built 3D models of them, from which they extracted the internal bone structure. Using a 3D printer, the scientists then printed 3D cores, based on virtual "core samples" taken from the mandibular condyle of each jaw joint, which they then scaled and tested for strength.

"Using a compression gauge, we measured how rigid these jaw joint structures were and how much force they could withstand," Wysocki said.

No significant correlation

The testing revealed no significant correlations between the shape or mechanical performance of the jaw joint bone and the diets of particular

carnivorans.

"The mandibular condyle absorbs compressive force during chewing so we hypothesized that this was a part of the skull that was likely to be influenced by what the animal eats," Wysocki said. "It turns out that body size is the key factor determining the complexity of jaw joint bone structure and strength."

He noted that some previous research has revealed that despite the wide variety of diets consumed by different carnivorans, the overall skull shape is considerably influenced by non-feeding variables.

"Still, given how critical the temporomandibular joint is in capturing prey and eating it, these results are very striking," he said. "For over a century, it has been assumed that skull shape is closely related to what an animal eats. And now we have found that jaw joint bone structure is related to carnivoran body size, not what the animal is eating."

Wysocki said that the reasons for this apparent disconnect may be that larger carnivorans don't need such powerful jaws because they are proportionately larger than their prey, or possibly because they share the work involved by hunting in groups. He also said that other factors such as developmental constraints of bone structure could play a role in producing the trends observed in the study.

"Our research shows that factors other than diet need to be considered when attempting to understand jaw joint function," Wysocki concluded. "It turns out that the functional anatomy of the jaw joint is much more complex than we thought."

For the record, the findings revealed that the species that demonstrated the greatest maximum compressive strength during chewing force simulations, was the wolverine (*Gulo gulo*), followed by the cheetah (*Acinonyx jubatus*), the malagasy civet (*Fossa fossana*), the honey badger (*Mellivora capensis*) and the kinkajou (*Potos flavus*).

DNA accessibility, gene expression jointly profiled in thousands of cells: New assay advances research on how various cells types interpret their genetic code -- ScienceDaily

Scientists have now developed an assay that concurrently profiles both the epigenome and transcriptome of each of thousands of single cells.

The epigenome and transcriptome are part of the molecular biology that converts a genetic blueprint into tools and materials for living cells.

The genomes of different types of cells may be identical, while their epigenomes and transcriptomes are not. The epigenome consists of a set of marks that shape what each cell's genome will do, while the transcriptome is the set of copies of the instructions themselves. These encode the production of proteins. The flow of information from the inherited plan to the making of proteins is critical for forming and maintaining life.

Cells can access only certain portions of their chromatin-packaged, double-stranded genome during RNA transcription. Because this access varies among different cell types, chromatin accessibility is what helps determine the shape, function and variety of the diverse cells in a multi-cellular, living organism.

The researchers call their assay sci-CAR. Sci stands for single-cell combinatorial indexing, a means of studying large numbers of single cells at once. In a research report Aug. 30 in *Science*, the scientists describe how the new assay merges two other genomic assays into one protocol.

These assays, among their other features, incorporate unique barcodes for the nucleic acid contents of cells or of the cell nucleus, which contains the main

control center for living cells. The scientists' method for labeling and sorting cells lets them link the messenger RNA and chromatin accessibility profiles of individual cells.

Most assays of what goes on genetically inside single cells, the scientists noted, can survey only one aspect of cellular biology. The ability to investigate several classes of molecules concurrently could uncover, for example, how certain genetic mechanisms are related and regulated.

It could also improve the usefulness of cell atlases of complex organisms, like those of the worm or mouse. Eventually, it could be helpful in compiling a human cell atlas.

The new method was developed by scientists at the Brotman Baty Institute for Precision Medicine in Seattle, University of Washington School of Medicine Department of Genome Sciences, Oregon Health Sciences University, Illumina, Inc., in California, Allen Discovery Center for Cell Lineage Tracing, and Howard Hughes Medical Institute.

The first author of the study is Junyue Cao, a graduate student in the Molecular and Cellular Biology program and in genome sciences at the University of Washington School of Medicine. The study was led by Jay Shendure and Cole Trapnell. Both are faculty in the Department of Genome Sciences at the UW School of Medicine and investigators at the Brotman Baty Institute, where Shendure is the director.

The researchers first tried their co-assay on more than 4,800 cells in a lung-cancer-derived cell culture model of cortisol response. In this model, the cells are treated with the corticosteroid dexamethasone. This synthetic steroid can activate the binding of thousands of locations on the genome and change the expression of hundreds of genes.

The scientists then examined the time course of dexamethasone's effects on gene expression, as well as dynamic changes that occurred in chromatin accessibility in the same cells.

In related work, the researchers sought to study the gene-control landscape that underlies the messenger RNA collections found in the different types of

cells in the mammalian kidney.

In applying their co-assay to the nuclei from whole mouse kidneys, they recovered both transcriptome and chromatin accessibility profiles from 11,296 cells. They clustered their mouse kidney cells into 14 groups, and characterized cell-type specific epigenome landscapes and linked transcriptome features.

Based on the covariance between epigenome and transcriptome, the researchers also learned that they could draw links between distant genomic regulatory elements and their targeted genes to explain some of the differences in gene expression across various cell types.

Looking forward, there are clear advantages of a joint assay over assays that only profile either RNA transcription or DNA accessibility. One advantage of sci-CAR specifically is that this method could potentially be used to jointly assay millions of single cells at once.

Among its limitations is the sparseness of some of the chromatin accessibility data. The researchers suggested that this might be overcome in future experiments by optimizing some aspects of the current protocol.

The researchers hope to continue to combine additional co-assays so that molecular biologists could concurrently trace the flow of genetic information from DNA to RNA to specific proteins in each of the many single cells that can exist in complex living things.

Most land-based ecosystems worldwide risk 'major transformation' due to climate change -- ScienceDaily

Without dramatic reductions in greenhouse-gas emissions, most of the planet's land-based ecosystems -- from its forests and grasslands to the deserts and tundra -- are at high risk of "major transformation" due to climate change, according to a new study from an international research team.

The researchers used fossil records of global vegetation change that occurred during a period of post-glacial warming to project the magnitude of ecosystem transformations likely in the future under various greenhouse gas emissions scenarios.

They found that under a "business as usual" emissions scenario, in which little is done to rein in heat-trapping greenhouse-gas emissions, vegetation changes across the planet's wild landscapes will likely be more far-reaching and disruptive than earlier studies suggested.

The changes would threaten global biodiversity and derail vital services that nature provides to humanity, such as water security, carbon storage and recreation, according to study co-author Jonathan Overpeck, dean of the School for Environment and Sustainability at the University of Michigan.

"If we allow climate change to go unchecked, the vegetation of this planet is going to look completely different than it does today, and that means a huge risk to the diversity of the planet," said Overpeck, who conceived the idea for the study with corresponding author Stephen T. Jackson of the U.S. Geological Survey.

The findings are scheduled for publication in the Aug. 31 edition of the journal *Science*. Forty-two researchers from around the world contributed to the paper. The first author is geosciences graduate student Connor Nolan of

the University of Arizona.

Overpeck stressed that the team's results are not merely hypothetical. Some of the expected vegetational changes are already underway in places like the American West and Southwest, where forest dieback and massive wildfires are transforming landscapes.

"We're talking about global landscape change that is ubiquitous and dramatic," Overpeck said. "And we're already starting to see it in the United States, as well as around the globe."

Previous studies based largely on computer modeling and present-day observations also predicted sweeping vegetational changes in response to climate warming due to the ongoing buildup of carbon dioxide and other greenhouse gases.

But the new study, which took five years to complete, is the first to use paleoecological data -- the records of past vegetation change present in ancient pollen grains and plant fossils from hundreds of sites worldwide -- to project the magnitude of future ecosystem changes on a global scale.

The team focused on vegetation changes that occurred during Earth's last deglaciation, a period of warming that began 21,000 years ago and that was roughly comparable in magnitude (4 to 7 degrees Celsius, or 7 to 13 degrees Fahrenheit) to the warming expected in the next 100 to 150 years if greenhouse gas emissions are not reduced significantly.

Because the amount of warming in the two periods is similar, a post-glacial to modern comparison provides "a conservative estimate of the extent of ecological transformation to which the planet will be committed under future climate scenarios," the authors wrote.

The estimate is considered conservative in part because the rate of projected future global warming is at least an order of magnitude greater than that of the last deglaciation and is therefore potentially far more disruptive.

"We're talking about the same amount of change in 10-to-20 thousand years that's going to be crammed into a century or two," said Jackson, director of

the U.S. Geological Survey's Southwest Climate Adaptation Center. "Ecosystems are going to be scrambling to catch up."

To determine the extent of the vegetation change following the last glacial peak, the researchers first compiled and evaluated pollen and plant-fossil records from 594 sites worldwide -- from every continent except Antarctica. All of the sites in their global database of ecological change had been reliably radiocarbon-dated to the period between 21,000 and 14,000 years before present.

Then they used paleoclimatic data from a number of sources to infer the corresponding temperature increases responsible for the vegetation changes seen in the fossils. That, in turn, enabled them to calculate how various levels of future warming will likely affect the planet's terrestrial vegetation and ecosystems.

"We used the results from the past to look at the risk of future ecosystem change," said the University of Arizona's Nolan. "We find that as temperatures rise, there are bigger and bigger risks for more ecosystem change."

Under a business as usual emissions scenario, the probability of large-scale vegetation change is greater than 60 percent, they concluded. In contrast, if greenhouse-gas emissions are reduced to levels targeted in the 2015 Paris Agreement, the probability of large-scale vegetation change is less than 45 percent.

Much of the change could occur during the 21st century, especially where vegetation disturbance is amplified by other factors, such as climate extremes, widespread plant mortality events, habitat fragmentation, invasive species and natural resource harvesting. The changes will likely continue into the 22nd century or beyond, the researchers concluded.

The ecosystem services that will be significantly impacted include carbon storage -- currently, vast amounts of carbon are stored in the plants and soils of land-based ecosystems.

"A lot of the carbon now locked up by vegetation around the planet could be

released to the atmosphere, further amplifying the magnitude of the climate change," Overpeck said.

The authors say their empirically based, paleoecological approach provides an independent perspective on climate-driven vegetation change that complements previous studies based on modeling and present-day observations.

The fact that predictions from these diverse approaches are converging "strengthens the inference that projected climate changes will drive major ecosystem transformations," the authors wrote.

"It's a huge challenge we as a nation and global community need to take more seriously," Overpeck said.

CRISPR halts Duchenne muscular dystrophy progression in dogs -- ScienceDaily

Scientists for the first time have used CRISPR gene editing to halt the progression of Duchenne muscular dystrophy (DMD) in a large mammal, according to a study by UT Southwestern that provides a strong indication that a lifesaving treatment may be in the pipeline.

The research published in *Science* documents unprecedented improvement in the muscle fibers of dogs with DMD -- the most common fatal genetic disease in children, caused by a mutation that inhibits the production of dystrophin, a protein critical for muscle function.

Researchers used a single-cut gene-editing technique to restore dystrophin in muscle and heart tissue by up to 92 percent of normal levels. Scientists have estimated a 15 percent threshold is needed to significantly help patients.

"Children with DMD often die either because their heart loses the strength to pump, or their diaphragm becomes too weak to breathe," said Dr. Eric Olson, Director of UT Southwestern's Hamon Center for Regenerative Science and Medicine. "This encouraging level of dystrophin expression would hopefully prevent that from happening."

DMD, which affects one in 5,000 boys, leads to muscle and heart failure, and premature death by the early 30s. Patients are forced into wheelchairs as their muscles degenerate and eventually onto respirators as their diaphragms weaken. No effective treatment exists, though scientists have known for decades that a defect in the dystrophin gene causes the condition.

The *Science* study establishes the proof-of-concept for single-cut gene editing in dystrophic muscle and represents a major step toward a clinical trial. Already Dr. Olson's team has corrected DMD mutations in mice and human

cells by making single cuts at strategic points of the mutated DNA.

The latest research applied the same technique in four dogs that shared the type of mutation most commonly seen in DMD patients. Scientists used a harmless virus called adeno-associated virus (AAV) to deliver CRISPR gene-editing components to exon 51, one of the 79 exons that comprise the dystrophin gene.

CRISPR edited the exon, and within several weeks the missing protein was restored in muscle tissue throughout the body, including 92 percent correction in the heart and 58 percent in the diaphragm, the main muscle needed for breathing.

"Our strategy is different from other therapeutic approaches for DMD because it edits the mutation that causes the disease and restores normal expression of the repaired dystrophin," said Dr. Leonela Amoasii, lead author of the study and Assistant Instructor of Molecular Biology in Dr. Olson's lab. "But we have more to do before we can use this clinically."

The lab will next conduct longer-term studies to measure whether the dystrophin levels remain stable and to ensure the gene edits do not have adverse side effects.

Dr. Olson hopes the next step beyond dogs is a clinical trial, which would be among several that UT Southwestern's gene therapy center aims to launch in the coming years to address numerous deadly childhood diseases.

In the meantime, Dr. Olson's recent work has spawned a biotechnology company, Exonics Therapeutics Inc., which is working to further optimize and bring this technology to the clinic. Exonics intends to extend the approach to additional DMD mutations, as well as other neuromuscular diseases. Exonics has licensed the technology from UT Southwestern.

Story Source:

Materials provided by **UT Southwestern Medical Center**. *Note: Content may be edited for style and length.*

Scientists decode opium poppy genome: Scientists have determined the DNA code of the opium poppy genome -- ScienceDaily

Scientists have determined the DNA code of the opium poppy genome, uncovering key steps in how the plant evolved to produce the pharmaceutical compounds used to make vital medicines.

The discovery may pave the way for scientists to improve yields and the disease resistance of the medicinal plant, securing a reliable and cheap supply of the most effective drugs for pain relief and palliative care.

The breakthrough, by researchers at the University of York in partnership with the Wellcome Sanger Institute, UK, and international colleagues, reveals the origins of the genetic pathway leading to the production of the cough suppressant noscapine and painkiller drugs morphine and codeine.

Co-corresponding author, Professor Ian Graham, from the Centre for Novel Agricultural Products, Department of Biology at the University of York, said: "Biochemists have been curious for decades about how plants have evolved to become one of the richest sources of chemical diversity on earth. Using high quality genome assembly, our study has deciphered how this has happened in opium poppy.

"At the same time this research will provide the foundation for the development of molecular plant breeding tools that can be used to ensure there is a reliable and cheap supply of the most effective painkillers available for pain relief and palliative care for societies in not just developed but also developing world countries."

Synthetic biology based approaches to manufacturing compounds such as noscapine, codeine and morphine are now being developed whereby genes from the plant are engineered into microbial systems such as yeast to enable

production in industrial fermenters. However, opium poppy remains the cheapest and sole commercial source of these pharmaceutical compounds by some distance.

The scientists from the University of York and Wellcome Sanger Institute in the United Kingdom together with colleagues from Xi'an Jiaotong University and Shanghai Ocean University in China and Sun Pharmaceutical Industries (Australia) Pty Ltd, produced a high quality assembly of the 2.7 GigaBase genome sequence distributed across 11 chromosomes.

This enabled the researchers to identify a large cluster of 15 genes that encode enzymes involved in two distinct biosynthetic pathways involved in the production of both noscapine and the compounds leading to codeine and morphine.

Plants have the capacity to duplicate their genomes and when this happens there is freedom for the duplicated genes to evolve to do other things. This has allowed plants to develop new machinery to make a diverse array of chemical compounds that are used to defend against attack from harmful microbes and herbivores and to attract beneficial species such as bees to assist in pollination.

The genome assembly allowed the researchers to identify the ancestral genes that came together to produce the STORR gene fusion that is responsible for the first major step on the pathway to morphine and codeine. This fusion event happened before a relatively recent whole genome duplication event in the opium poppy genome 7.8 million years ago.

Co-corresponding author Professor Kai Ye from Xi'an Jiaotong University said "A highly repetitive plant genome and the intermingled evolutionary events in the past 100 million years complicated our analysis. We utilized complementary cutting-edge genome sequencing technologies with sophisticated mathematical models and analysis methods to investigate the evolutionary history of the opium poppy genome.

"It is intriguing that two biosynthetic pathways came to the same genomic region due to a series of duplication, shuffling and fusion structural events, enabling concerted production of novel metabolic compounds."

Joint first author Professor Zemin Ning from the Wellcome Trust Sanger Institute said "Combining various sequencing technologies is the key for producing a high quality assembly for opium poppy genome. With a genome size similar to humans, the main challenge for this project was to handle repeat elements which make up 70.9% of the genome."

Story Source:

Materials provided by **University of York**. *Note: Content may be edited for style and length.*

Adapt, move or die: How biodiversity reacted to past climate change -- ScienceDaily

A new paper reviews current knowledge on climate change and biodiversity. In the past, plants and animals reacted to environmental changes by adapting, migrating or going extinct. These findings point to radical changes in biodiversity due to climate change in the future. The paper is published in the scientific journal *Trends in Ecology and Evolution* by an international group of scientists led by the Center for Macroecology, Evolution and Climate, University of Copenhagen.

Nature is reacting to climate change. We see altered behaviour and movement among plants and animals; flowers change flowering period and owls get darker body colour, due to warmer winters. So, how does the future for biodiversity look like? Will plants and animals be able to adjust quickly enough to survive the changing temperatures, precipitation and seasons? Lead-author of a new study Professor David Bravo-Nogues from Center for Macroecology, Evolution and Climate, University of Copenhagen, explains,

"We compiled an enormous amount of studies of events, which we know influenced biodiversity during the past million years. It turns out species have been able to survive new conditions in their habitat by changing either their behaviour or body shape. However, the current magnitude and unseen speed of change in nature may push species beyond their ability to adapt."

Too fast changes leave species small chances

Until now, scientists thought species' main reaction to climatic changes was to move. However, the new study shows that local adaptation to new conditions seems to have played a key role in the way species survived. Species adapt when the whole population change, e.g. when all owls get darker body colour. This happens slowly over a long period of time.

Coauthor Stephen Jackson, director of the US Geological Survey's Southwest Climate Adaptation Science Center, elaborates,

"From fossils and other biological "archives" we have access to a nearly limitless number of case studies throughout Earth's history. This provide us with valuable knowledge of how climate changes of various rates, magnitudes, and types can affect biodiversity."

Past extinctions help to protect future biodiversity

The new study might give us the answer to decode how biodiversity changes under climate change. This knowledge can inform policy-makers in order to implement effective conservation schemes in the future. Some species, when failed to adapt or move fast enough, like the orange-spotted filefish, have already gone extinct due to climate change. Co-author Francisco Rodriguez-Sanchez from the Spanish Research Council (CSIC), says,

"We know animals and plants have prevented extinction by adapt or migrate in the past. However, the models we use today to predict future climate change, foresee magnitudes and rates of change, which have been exceptionally rare in the last million years. Thus, we need to expand our knowledge and improve our prediction models. Also, we must recognise the limitations of the models, because they are used to inform politicians and decision-makers about effects of climate change on biodiversity."

Story Source:

Materials provided by **Faculty of Science - University of Copenhagen**.
Note: Content may be edited for style and length.

Climate change projected to boost insect activity and crop loss, researchers say -- ScienceDaily

Scientists have already warned that climate change likely will impact the food we grow. From rising global temperatures to more frequent "extreme" weather events like droughts and floods, climate change is expected to negatively affect our ability to produce food for a growing human population.

But new research is showing that climate change is expected to accelerate rates of crop loss due to the activity of another group of hungry creatures -- insects. In a paper published Aug. 31 in the journal *Science*, a team led by scientists at the University of Washington reports that insect activity in today's temperate, crop-growing regions will rise along with temperatures. Researchers project that this activity, in turn, will boost worldwide losses of rice, corn and wheat by 10-25 percent for each degree Celsius that global mean surface temperatures rise. Just a 2-degree Celsius rise in surface temperatures will push the total losses of these three crops each year to approximately 213 million tons.

"We expect to see increasing crop losses due to insect activity for two basic reasons," said co-lead and corresponding author Curtis Deutsch, a UW associate professor of oceanography. "First, warmer temperatures increase insect metabolic rates exponentially. Second, with the exception of the tropics, warmer temperatures will increase the reproductive rates of insects. You have more insects, and they're eating more."

In 2016, the United Nations estimated that at least 815 million people worldwide don't get enough to eat. Corn, rice and wheat are staple crops for about 4 billion people, and account for about two-thirds of the food energy intake, according to the UN Food and Agriculture Organization.

"Global warming impacts on pest infestations will aggravate the problems of

food insecurity and environmental damages from agriculture worldwide," said co-author Rosamond Naylor, a professor in the Department of Earth System Science at Stanford University and founding director of the Center on Food Security and the Environment. "Increased pesticide applications, the use of GMOs, and agronomic practices such as crop rotations will help control losses from insects. But it still appears that under virtually all climate change scenarios, pest populations will be the winners, particularly in highly productive temperate regions, causing real food prices to rise and food-insecure families to suffer."

To investigate how insect herbivory on crops might affect our future, the team looked at decades of laboratory experiments of insect metabolic and reproductive rates, as well as ecological studies of insects in the wild. Unlike mammals, insects are ectothermic, which means that their body temperature tracks the temperature of their environment. Thus, the air temperature affects oxygen consumption, caloric requirements and other metabolic rates.

The past experiments that the team studied show conclusively that increases in temperature will accelerate insect metabolism, which boosts their appetites, at a predictable rate. In addition, increasing temperatures boost reproductive rates up to a point, and then those rates level off at temperature levels akin to what exist today in the tropics.

Deutsch and his colleagues found that the effects of temperature on insect metabolism and demographics were fairly consistent across insect species, including pest species such as aphids and corn borers. They folded these metabolic and reproductive effects into a model of insect population dynamics, and looked at how that model changed based on different climate change scenarios. Those scenarios incorporated information based on where corn, rice and wheat -- the three largest staple crops in the world -- are currently grown.

For a 2-degree Celsius rise in global mean surface temperatures, their model predicts that median losses in yield due to insect activity would be 31 percent for corn, 19 percent for rice and 46 percent for wheat. Under those conditions, total annual crop losses would reach 62, 92 and 59 million tons, respectively.

The researchers observed different loss rates due to the crops' different growing regions, Deutsch said. For example, much of the world's rice is grown in the tropics. Temperatures there are already at optimal conditions to maximize insect reproductive and metabolic rates. So, additional increases in temperature in the tropics would not boost insect activity to the same extent that they would in temperate regions -- such as the United States' "corn belt."

The team notes that farmers and governments could try to lessen the impact of increased insect metabolism, such as shifting where crops are grown or trying to breed insect-resistant crops. But these alterations will take time and come with their own costs.

"I hope our results demonstrate the importance of collecting more data on how pests will impact crop losses in a warming world -- because collectively, our choice now is not whether or not we will allow warming to occur, but how much warming we're willing to tolerate," said Deutsch.

Guiding flight: The fruit fly's celestial compass: How the common fruit fly uses the sun to navigate -- ScienceDaily

What do ancient seafaring explorers and fruit flies have in common? Caltech researchers have discovered that, similar to nautical navigators of old, fruit flies use celestial cues like the sun to navigate in straight lines.

The research is described in a paper appearing online on August 30 in the journal *Current Biology*. The work was done in the laboratory of Michael Dickinson, Esther M. and Abe M. Zarem Professor of Bioengineering and Aeronautics. Dickinson is an affiliated faculty member of the Tianqiao and Chrissy Chen Institute for Neuroscience at Caltech.

Imagine you're wandering alone through a vast desert -- the landscape is barren and the sun is blazing. There are no landmarks to guide you, but accidentally going in circles could mean death. Whatever direction you choose, you need to be able to head straight.

This is the conundrum of *Drosophila*, the common fruit fly, in the desert. Almost 40 years ago, a study found that fruit flies can fly up to nine miles in one night in search of food and water. How are these tiny insects able to navigate such long distances?

"For flies crossing inhospitable territory, flying around in circles would be really dangerous -- they're less likely to find any food or water," says postdoctoral scholar Ysabel Giraldo, the study's first author. "Surprisingly, fruit flies are seasonally found in environments like the Mojave Desert. They must get there from somewhere, and once there, they must figure out how to get around."

Giraldo and her collaborators found that fruit flies navigate using the sun as a landmark. The researchers placed flies in a "flight simulator" -- a kind of

virtual reality where they are held in place but can still move their wings in response to visual stimuli. The researchers found that a fly will fix a small, bright spot (the simulated sun) in one position within its field of vision and fly straight with respect to that position. When the team removed this landmark and reintroduced it a few hours later, the same fly could remember and adopt its former orientation, or heading. Each fly they tested selected a different heading, suggesting that under natural conditions, flies in a group would disperse in many directions.

"It was a bit surprising to find that the same pesky little flies that flit around fruit bowls and wine glasses have the capacity to navigate for many miles using the sun," says Dickinson.

The research also shows that these flies have so-called compass neurons in their brains that seem to be associated with this navigational behavior. Genetically silencing these neurons (rendering them unable to function) removed a fly's ability to create a heading based on the sun. Instead, the fly adopted a more simple, reflexive behavior of flying straight towards the light. Using genetic tools, Giraldo and her team were also able to modify these neurons so that they would fluoresce according to the neurons' activity levels. Then, by making a very tiny hole in the fly's head and using a powerful microscope, the researchers could watch neural activity while the fly was in the simulator.

"Insects have been navigating for many millions of years, so we think of this as a very ancient toolkit," says Giraldo. "We know a fair bit about navigation in other insects like Monarch butterflies and locusts -- seasonally migrating insects whose behaviors are noticeable or affect us directly. Although relatively little is known about how fruit flies navigate and disperse, the availability of genetic tools for *Drosophila* makes them a powerful system to understand the mechanisms underlying behavior. In fact, because the anatomy or architecture of *Drosophila* brains is very similar to these other insects' brains, what we learn from fruit flies is likely to be relevant to them."

The next steps for this research, according to Giraldo, are multifaceted.

"There are several different directions we can go with this work," she says. "For example, we know the compass neurons must be one part of a more

complex navigational circuit, and we'd like to explore that circuit. If the flies are remembering their heading over time, how do they do that? We're also examining whether there are seasonal differences in navigation patterns by taking flies that are basically genetically identical and rearing them at different temperatures and daylengths. Does rearing condition cause behavioral differences? It's related to the question of how and why flies get to inhospitable environments at various times of the year."

Solar eruptions may not have slinky-like shapes after all -- ScienceDaily

As the saying goes, everything old is new again. While the common phrase often refers to fashion, design, or technology, scientists at the University of New Hampshire have found there is some truth to this mantra even when it comes to research. Revisiting some older data, the researchers discovered new information about the shape of coronal mass ejections (CMEs) -- large-scale eruptions of plasma and magnetic field from the sun -- that could one day help protect satellites in space as well as the electrical grid on Earth.

"Since the late 1970s, coronal mass ejections have been assumed to resemble a large Slinky -- one of those spring toys -- with both ends anchored at the sun, even when they reach Earth about one to three days after they erupt," said Noe Lugaz, research associate professor in the UNH Space Science Center. "But our research suggests their shapes are possibly different."

Knowing the shape and size of CMEs is important because it can help better forecast when and how they will impact Earth. While they are one of the main sources for creating beautiful and intense auroras, like the Northern and Southern Lights, they can also damage satellites, disrupt radio communications and wreak havoc on the electrical transmission system causing massive and long-lasting power outages. Right now, only single point measurements exist for CMEs making it hard for scientists to judge their shapes. But these measurements have been helpful to space forecasters, allowing them a 30 to 60 minute warning before impact. The goal is to lengthen that notice time to hours -- ideally 24 hours -- to make more informed decisions on whether to power down satellites or the grid.

In their study, published in *Astrophysical Journal Letters*, the researchers took a closer look at data from two NASA spacecraft, Wind and ACE, typically orbiting upstream of Earth. They analyzed the data of 21 CMEs over a two-year period between 2000 and 2002 when Wind had separated from ACE. Wind had only separated one percent of one astronomical unit

(AU), which is the distance from the sun to the Earth (93,000,000 miles). So, instead of now being in front of Earth, with ACE, Wind was now perpendicular to the Sun-Earth line, or on the side.

"Because they are usually so close to one another, very few people compare the data from both Wind and ACE," said Lugaz. "But 15 years ago, they were apart and in the right place for us to go back and notice the difference in measurements, and the differences became larger with increasing separations, making us question the Slinky shape."

The data points toward a few other shape possibilities: CMEs are not simple Slinky shapes (they might be deformed ones or something else entirely), or CMEs are Slinky-shaped but on a much smaller scale (roughly four times smaller) than previously thought.

While the researchers say more studies are needed, Lugaz says this information could be important for future space weather forecasting. With other missions being considered by NASA and NOAA, the researchers say this study shows that future spacecraft may first need to investigate how close to the Sun-Earth line they have to remain to make helpful and more advanced forecast predictions.

This research was supported by NASA and the National Science Foundation.

Story Source:

Materials provided by **University of New Hampshire**. *Note: Content may be edited for style and length.*

Human genome could contain up to 20 percent fewer genes, researchers reveal -- ScienceDaily

A new study led by the Spanish National Cancer Research Centre (CNIO) reveals that up to 20% of genes classified as coding (those that produce the proteins that are the building blocks of all living things) may not be coding after all because they have characteristics that are typical of non-coding or pseudogenes (obsolete coding genes). The consequent reduction in the size of the human genome could have important effects in biomedicine since the number of genes that produce proteins and their identification is of vital importance for the investigation of multiple diseases, including cancer, cardiovascular diseases, etc.

The work, published in the journal *Nucleic Acids Research*, is the result of an international collaboration led by Michael Tress of the CNIO Bioinformatics Unit along with researchers from the Wellcome Trust Sanger Institute in the United Kingdom, the Massachusetts Institute of Technology in the United States, the Pompeu Fabra University and the National Center for Supercomputing (BSC-CNS) in Barcelona, and the National Center for Cardiovascular Research (CNIC) in Madrid.

Since the completion of the sequencing of the human genome in 2003 experts from around the world have been working to compile the final human proteome (the total number of proteins generated from genes) and the genes that produce them. This task is immense given the complexity of the human genome and the fact that we have about 20,000 separate coding genes.

The researchers analyzed the genes cataloged as protein coding in the main reference human proteomes: the detailed comparison of the reference proteomes from GENCODE/Ensembl, RefSeq and UniProtKB found 22,210 coding genes, but only 19,446 of these genes were present in all 3 annotations.

When they analyzed the 2,764 genes that were present in only one or two of these reference annotations, they were surprised to discover that experimental evidence and manual annotations suggested that almost all of these genes were more likely to be non-coding genes or pseudogenes. In fact, these genes, together with another 1,470 coding genes that are present in the three reference catalogs, were not evolving like typical protein coding genes. The conclusion of the study is that most of these 4,234 genes probably do not code for proteins.

The study is already paying off, according to the scientists. "We have been able to analyze many of these genes in detail," Tress explains, "and more than 300 genes have already been reclassified as non-coding." The results are already being included in the new annotations of the human genome by the GENCODE international consortium, of which the CNIO researchers are part.

Conflicting gene numbers in recent years

The work once again highlights doubts about the number of real genes present in human cells 15 years after the sequencing the human genome. Although the most recent data indicates that the number of genes encoding human proteins could exceed 20,000, Federico Abascal, of the Wellcome Trust Sanger Institute in the United Kingdom and first author of the work, states: "Our evidence suggests that humans may only have 19,000 coding genes, but we still do not know which 19,000 genes are."

For his part, David Juan, of the Pompeu Fabra University and participant in the study, reiterates the importance of these results: "Surprisingly, some of these unusual genes have been well studied and have more than 100 scientific publications based on the assumption that the gene produces a protein. "

This study suggests that there is still a large amount of uncertainty, since the final number of coding genes could 2,000 more or 2,000 fewer than it is now. The human proteome still requires much work, especially given its importance to the medical community.

The work has been funded by the US National Institutes of Health.

Deadline for climate action: Act strongly before 2035 to keep warming below 2°C -- ScienceDaily

If governments don't act decisively by 2035 to fight climate change, humanity could cross a point of no return after which limiting global warming below 2°C in 2100 will be unlikely, according to a new study by scientists in the UK and the Netherlands. The research also shows the deadline to limit warming to 1.5°C has already passed, unless radical climate action is taken. The study is published today in the European Geosciences Union journal *Earth System Dynamics*.

"In our study we show that there are strict deadlines for taking climate action," says Henk Dijkstra, a professor at Utrecht University in the Netherlands and one of the study authors. "We conclude that very little time is left before the Paris targets [to limit global warming to 1.5°C or 2°C] become infeasible even given drastic emission reduction strategies."

Dijkstra and his colleagues at the Utrecht Centre for Complex Systems Studies and at Oxford University, UK, wanted to find the 'point of no return' or deadline for climate action: the latest possible year to start strongly cutting greenhouse-gas emissions before it's too late to avoid dangerous climate change. "The 'point of no return' concept has the advantage of containing time information, which we consider very useful to inform the debate on the urgency of taking climate action," says Matthias Aengenheyster, a doctoral researcher at Oxford University and the study's lead author.

Using information from climate models, the team determined the deadline for starting climate action to keep global warming likely (with a probability of 67%) below 2°C in 2100, depending on how fast humanity can reduce emissions by using more renewable energy. Assuming we could increase the share of renewable energy by 2% every year, we would have to start doing so before 2035 (the point of no return). If we were to reduce emissions at a

faster rate, by increasing the share of renewable energy by 5% each year, we would buy another 10 years.

The researchers caution, however, that even their more modest climate-action scenario is quite ambitious. "The share of renewable energy refers to the share of all energy consumed. This has risen over the course of over two decades from almost nothing in the late nineties to 3.6% in 2017 according to the BP Statistical Review, so the [yearly] increases in the share of renewables have been very small," says Rick van der Ploeg, a professor of economics at Oxford University, who also took part in the *Earth System Dynamics* study. "Considering the slow speed of large-scale political and economic transformations, decisive action is still warranted as the modest-action scenario is a large change compared to current emission rates," he adds.

To likely limit global warming to 1.5°C in 2100, humanity would have to take strong climate action much sooner. We would only have until 2027 to start if we could increase the share of renewables at a rate of 5% a year. We have already passed the point of no return for the more modest climate-action scenario where the share of renewables increases by 2% each year. In this scenario, unless we remove carbon dioxide from the atmosphere, it is no longer possible to achieve the 1.5°C target in 2100 with a probability of 67%.

Removing greenhouse gases from the atmosphere, by using 'negative emissions' technology, could buy us a bit more time, according to the study. But even with strong negative emissions, humanity would only be able to delay the point of no return by 6 to 10 years.

"We hope that 'having a deadline' may stimulate the sense of urgency to act for politicians and policy makers," concludes Dijkstra. "Very little time is left to achieve the Paris targets."

Story Source:

Materials provided by **European Geosciences Union**. *Note: Content may be edited for style and length.*

Engineered sand zaps storm water pollutants: Technology could help provide local source of drinking water for parched communities -- ScienceDaily

University of California, Berkeley, engineers have created a new way to remove contaminants from storm water, potentially addressing the needs of water-stressed communities that are searching for ways to tap the abundant and yet underused source of fresh drinking water.

Using a mineral-coated sand that reacts with and destroys organic pollutants, the researchers have discovered that the engineered sand could help purify storm water percolating into underground aquifers, creating a safe and local reservoir of drinking water for parched communities.

"The way we treat storm water, especially in California, is broken. We think of it as a pollutant, but we should be thinking about it as a solution," said Joseph Charbonnet, a graduate student in civil and environmental engineering at UC Berkeley. "We have developed a technology that can remove contamination before we put it in our drinking water in a passive, low-cost, non-invasive way using naturally-occurring minerals."

As rain water rushes over our roofs, lawns and streets, it can pick up a slew of nasty chemicals such as herbicides, pesticides, toxic metals, car oil and even dog poop. Excess storm water can also overwhelm sewer systems and flood streets and basements. Not surprisingly, cities often discharge this polluted water into neighboring rivers and streams as quickly as possible.

Directing storm water through sand into underground aquifers may be an ideal solution for gathering water in cities with Mediterranean climates like Los Angeles, Charbonnet said. Like giant rain barrels, aquifers can be filled during periods of intense rainfall and then store water until it is needed in the

dry season.

Cities are already using storm water reclamation on smaller scales through constructs such as bioswales and rain gardens, which funnel storm water through sand or mulch to remove debris and prevent surface runoff. In the Sun Valley neighborhood of Los Angeles, Charbonnet and his adviser, David Sedlak, are working with the local community to transform a 46-acre gravel pit into a wetland and water infiltration system for storm water.

"Before we built the buildings, roads and parking lots that comprise our cities, rainwater would percolate into the ground and recharge groundwater aquifers," said Sedlak, professor of civil and environmental engineering at UC Berkeley and co-director of the Berkeley Water Center. "As utilities in water stressed regions try to figure out how to get urban storm water back into the ground, the issue of water quality has become a major concern. Our coated sands represent an inexpensive, new approach that can remove many of the contaminants that pose risks to groundwater systems where storm water is being infiltrated."

Although the coated sand doesn't remove all types of contaminants, it may be used in conjunction with other water purification systems to remove many of the contaminants that water picks up, Sedlak said.

The team details the finding Aug. 30 in the journal *Environmental Science & Technology*.

To create the coated sand, Charbonnet mixed plain sand with two forms of manganese that react to form manganese oxide. This harmless mineral binds to organic chemicals such as herbicides, pesticides, and the endocrine-disrupting bisphenol-A (BPA) and breaks them down into smaller pieces that are usually less toxic and more biodegradable.

"Manganese oxides are something that soil scientists identified 30 or 40 years ago as having these really interesting properties, but we are one of the first groups to use it in engineered ways to help unlock this water source," Charbonnet said.

The manganese oxide-coated sand, which is a dull brown color, is safe and

environmentally friendly. "I guarantee that you have some manganese oxide on your shoe right now because it is ubiquitous in the soil," Charbonnet said.

Charbonnet tested the sand by percolating simulated storm water, which contained a low concentration of BPA, through columns of the material. The coated sand initially removed nearly all of the BPA, but lost its effectiveness over time. However, the manganese oxide could be "recharged" by bathing the sand in a solution containing a low concentration of chlorine. Recharging the sand restored all of the manganese oxide's initial reactivity.

"If you have to come in every year or two and dig up this sand and replace it, that is incredibly labor intensive, so in order to make this useful for community stakeholders it's really important that this stuff can be regenerated in place," Charbonnet said.

Charbonnet estimates that it would take about two days to recharge a half-meter-deep layer of sand using 25 parts per million of chlorine in water, the concentration used to treat wastewater.

In the next phase of the experiment, the team is performing field tests in Sonoma County using storm water from a local creek.

How a NASA scientist looks in the depths of the great red spot to find water on Jupiter -- ScienceDaily

For centuries, scientists have worked to understand the makeup of Jupiter. It's no wonder: this mysterious planet is the biggest one in our solar system by far, and chemically, the closest relative to the Sun. Understanding Jupiter is a key to learning more about how our solar system formed, and even about how other solar systems develop.

But one critical question has bedeviled astronomers for generations: Is there water deep in Jupiter's atmosphere, and if so, how much?

Gordon L. Bjoraker, an astrophysicist at NASA's Goddard Space Flight Center in Greenbelt, Maryland, reported in a recent paper in the *Astronomical Journal* that he and his team have brought the Jovian research community closer to the answer.

By looking from ground-based telescopes at wavelengths sensitive to thermal radiation leaking from the depths of Jupiter's persistent storm, the Great Red Spot, they detected the chemical signatures of water above the planet's deepest clouds. The pressure of the water, the researchers concluded, combined with their measurements of another oxygen-bearing gas, carbon monoxide, imply that Jupiter has 2 to 9 times more oxygen than the sun. This finding supports theoretical and computer-simulation models that have predicted abundant water (H2O) on Jupiter made of oxygen (O) tied up with molecular hydrogen (H2).

The revelation was stirring given that the team's experiment could have easily failed. The Great Red Spot is full of dense clouds, which makes it hard for electromagnetic energy to escape and teach astronomers anything about the chemistry within.

"It turns out they're not so thick that they block our ability to see deeply," said Bjoraker. "That's been a pleasant surprise."

New spectroscopic technology and sheer curiosity gave the team a boost in peering deep inside Jupiter, which has an atmosphere thousands of miles deep, Bjoraker said: "We thought, well, let's just see what's out there."

The data Bjoraker and his team collected will supplement the information NASA's Juno spacecraft is gathering as it circles the planet from north to south once every 53 days.

Among other things, Juno is looking for water with its own infrared spectrometer and with a microwave radiometer that can probe deeper than anyone has seen -- to 100 bars, or 100 times the atmospheric pressure at Earth's surface. (Altitude on Jupiter is measured in bars, which represent atmospheric pressure, since the planet does not have a surface, like Earth, from which to measure elevation.)

If Juno returns similar water findings, thereby backing Bjoraker's ground-based technique, it could open a new window into solving the water problem, said Goddard's Amy Simon, a planetary atmospheres expert.

"If it works, then maybe we can apply it elsewhere, like Saturn, Uranus or Neptune, where we don't have a Juno," she said.

Juno is the latest spacecraft tasked with finding water, likely in gas form, on this giant gaseous planet.

Water is a significant and abundant molecule in our solar system. It spawned life on Earth and now lubricates many of its most essential processes, including weather. It's a critical factor in Jupiter's turbulent weather, too, and in determining whether the planet has a core made of rock and ice.

Jupiter is thought to be the first planet to have formed by siphoning the elements left over from the formation of the Sun as our star coalesced from an amorphous nebula into the fiery ball of gases we see today. A widely accepted theory until several decades ago was that Jupiter was identical in composition to the Sun; a ball of hydrogen with a hint of helium -- all gas, no

core.

But evidence is mounting that Jupiter has a core, possibly 10 times Earth's mass. Spacecraft that previously visited the planet found chemical evidence that it formed a core of rock and water ice before it mixed with gases from the solar nebula to make its atmosphere. The way Jupiter's gravity tugs on Juno also supports this theory. There's even lightning and thunder on the planet, phenomena fueled by moisture.

"The moons that orbit Jupiter are mostly water ice, so the whole neighborhood has plenty of water," said Bjoraker. "Why wouldn't the planet -- which is this huge gravity well, where everything falls into it -- be water rich, too?"

The water question has stumped planetary scientists; virtually every time evidence of H2O materializes, something happens to put them off the scent. A favorite example among Jupiter experts is NASA's Galileo spacecraft, which dropped a probe into the atmosphere in 1995 that wound up in an unusually dry region. "It's like sending a probe to Earth, landing in the Mojave Desert, and concluding the Earth is dry," pointed out Bjoraker.

In their search for water, Bjoraker and his team used radiation data collected from the summit of Maunakea in Hawaii in 2017. They relied on the most sensitive infrared telescope on Earth at the W.M. Keck Observatory, and also on a new instrument that can detect a wider range of gases at the NASA Infrared Telescope Facility.

The idea was to analyze the light energy emitted through Jupiter's clouds in order to identify the altitudes of its cloud layers. This would help the scientists determine temperature and other conditions that influence the types of gases that can survive in those regions.

Planetary atmosphere experts expect that there are three cloud layers on Jupiter: a lower layer made of water ice and liquid water, a middle one made of ammonia and sulfur, and an upper layer made of ammonia.

To confirm this through ground-based observations, Bjoraker's team looked at wavelengths in the infrared range of light where most gases don't absorb

heat, allowing chemical signatures to leak out. Specifically, they analyzed the absorption patterns of a form of methane gas. Because Jupiter is too warm for methane to freeze, its abundance should not change from one place to another on the planet.

"If you see that the strength of methane lines vary from inside to outside of the Great Red Spot, it's not because there's more methane here than there," said Bjoraker, "it's because there are thicker, deep clouds that are blocking the radiation in the Great Red Spot."

Bjoraker's team found evidence for the three cloud layers in the Great Red Spot, supporting earlier models. The deepest cloud layer is at 5 bars, the team concluded, right where the temperature reaches the freezing point for water, said Bjoraker, "so I say that we very likely found a water cloud." The location of the water cloud, plus the amount of carbon monoxide that the researchers identified on Jupiter, confirms that Jupiter is rich in oxygen and, thus, water.

Bjoraker's technique now needs to be tested on other parts of Jupiter to get a full picture of global water abundance, and his data squared with Juno's findings.

"Jupiter's water abundance will tell us a lot about how the giant planet formed, but only if we can figure out how much water there is in the entire planet," said Steven M. Levin, a Juno project scientist at NASA's Jet Propulsion Laboratory in Pasadena, Calif.

'Archived' heat has reached deep into the Arctic interior, researchers say -- ScienceDaily

Arctic sea ice isn't just threatened by the melting of ice around its edges, a new study has found: Warmer water that originated hundreds of miles away has penetrated deep into the interior of the Arctic.

That "archived" heat, currently trapped below the surface, has the potential to melt the region's entire sea-ice pack if it reaches the surface, researchers say.

The study appears online Aug. 29 in the journal *Science Advances*.

"We document a striking ocean warming in one of the main basins of the interior Arctic Ocean, the Canadian Basin," said lead author Mary-Louise Timmermans, a professor of geology and geophysics at Yale University.

The upper ocean in the Canadian Basin has seen a two-fold increase in heat content over the past 30 years, the researchers said. They traced the source to waters hundreds of miles to the south, where reduced sea ice has left the surface ocean more exposed to summer solar warming. In turn, Arctic winds are driving the warmer water north, but below the surface waters.

"This means the effects of sea-ice loss are not limited to the ice-free regions themselves, but also lead to increased heat accumulation in the interior of the Arctic Ocean that can have climate effects well beyond the summer season," Timmermans said. "Presently this heat is trapped below the surface layer. Should it be mixed up to the surface, there is enough heat to entirely melt the sea-ice pack that covers this region for most of the year."

The co-authors of the study are John Toole and Richard Krishfield of the Woods Hole Oceanographic Institution.

The National Science Foundation Division of Polar Programs provided

support for the research.

Story Source:

Materials provided by **Yale University**. Original written by Jim Shelton.
Note: Content may be edited for style and length.

Early amber trade: Sicilian amber in Western Europe predates arrival of Baltic amber by at least 2,000 years -- ScienceDaily

Amber and other unusual materials such as jade, obsidian and rock crystal have attracted interest as raw materials for the manufacture of decorative items since Late Prehistory and, indeed, amber retains a high value in present-day jewellery.

'Baltic' amber from Scandinavia is often cited as a key material circulating in prehistoric Europe, but in a new study published today in *PLOS ONE* researchers have found that amber from Sicily was travelling around the Western Mediterranean as early as the 4th Millennium BC -- at least 2,000 years before the arrival of any Baltic amber in Iberia.

According to lead author Dr Mercedes Murillo-Barroso of the Universidad de Granada, "The new evidence presented in this study has allowed the most comprehensive review to date on the provision and exchange of amber in the Prehistory of Iberia. Thanks to this new work, we now have evidence of the arrival of Sicilian amber in Iberia from at least the 4th Millennium BC."

"Interestingly, the first amber objects recovered in Sicily and identified as being made from the local amber there (known as simetite) also date from the 4th Millennium BC, however, there is no other evidence indicating direct contact between Sicily and Iberia at this time."

"Instead, what we do know about are the links between the Iberian Peninsula and North Africa. It is plausible that Sicilian amber reached Iberia through exchanges with North Africa. This amber appears at southern Iberian sites and its distribution is similar to that of ivory objects, suggesting that both materials reached the Iberian Peninsula following the same or similar

channels."

Senior author Professor Marcos Martinón-Torres, of the Department of Archaeology, University of Cambridge adds, "It is only from the Late Bronze Age that we see Baltic amber at a large number of Iberian sites and it is likely that it arrived via the Mediterranean, rather than through direct trade with Scandinavia."

"What's peculiar is that this amber appears as associated with iron, silver and ceramics pointing to Mediterranean connections. This suggests that amber from the North may have moved South across Central Europe before being shipped to the West by Mediterranean sailors, challenging previous suggestions of direct trade between Scandinavia and Iberia."

Murillo-Barroso concludes, "In this study, we've been able to overcome traditional challenges in attempts at assigning corroded amber to a geological source. These new analytical techniques can be used a reference to identify Sicilian amber, even from highly deteriorated archaeological samples."

"There are still unresolved issues to be investigated in the future -- namely exploring the presence of amber in North African contexts from the same time period and further researching the networks involved in the introduction and spread of Baltic amber in Iberia and the extent to which metals or other Iberian commodities were provided in return."

Story Source:

Protect key habitats, not just wilderness, to preserve species -- ScienceDaily

Some scientists have suggested we need to protect half of Earth's surface to preserve most of its species. A new Duke University-led study, however, cautions that it is the quality, not merely the quantity, of what we protect that matters.

"There's a lot of discussion about protecting 'Half Earth' as a minimum to protect biodiversity. The challenge is, which half do we protect?" said Stuart L. Pimm, Doris Duke Professor of Conservation Ecology at Duke's Nicholas School of the Environment, who was lead author of the new study.

"The predilection of national governments is to protect areas that are 'wild' -- that is, typically remote, cold, or arid," Pimm said. "Unfortunately, those areas often hold relatively few species. Our analysis shows that protecting even as much as half of the world's large wilderness areas will not protect many more species than at present."

To protect as many at-risk species as possible, especially those with small ranges, governments should expand their conservation focus and prioritize the protection of key habitats outside existing wildernesses, parks and preserves, Pimm and his coauthors from China and Brazil say.

"If we are to protect most species from extinction we have to protect the right places -- special places -- not just more area, per se," said Binbin Li, assistant professor of environmental sciences at Duke Kunshan University in China.

The team's new peer-reviewed study, published August 29 in *Science Advances*, uses geospatial analysis to map how well the world's current system of protected areas overlaps the ranges of nearly 20,000 species of mammals, birds and amphibians, the species that scientists know best.

"We found that global conservation efforts have enhanced protection for

many species -- for example, nearly half the species of birds with the smallest geographical ranges now have at least part of their ranges protected to a degree -- but critical gaps still exist," said Clinton Jenkins, of Brazil's Instituto de Pesquisas Ecológicas.

These gaps occur worldwide, including in biodiversity hotspots such as the northern Andes, the coastal forests of Brazil, and southwestern China, and they will continue to persist even if governments protect to up to half of the world's remaining wild areas, the study shows.

"Certainly, there are good reasons to protect large wild areas: they provide environmental services," Pimm said. "An obvious example is the Amazon, where the loss of the forest there might cause massive changes to the climate. But to save as much biodiversity as possible, we have to identify the species that remain poorly protected -- which this paper does -- and then pinpoint where they are, so we can effect practical conservation."

Many of the unprotected habitats are small parcels of land in areas where human impacts are already felt, disqualifying them for protection as wildernesses.

Pimm, Jenkins and Li lead a nonprofit organization called SavingSpecies that partners with local conservation groups in South America, Asia and other regions to protect such lands.

"The 'Half Earth' approach provides an inspiring vision to protect the world's species," Pimm said. "A preoccupation with concentrating on the total area protected is misleading, however. It's quality, not quantity that matters."

Story Source:

Materials provided by **Duke University**. *Note: Content may be edited for style and length.*

Not so fast: From shrews to elephants, animal reflexes surprisingly slow -- ScienceDaily

While speediness is a priority for any animal trying to escape a predator or avoid a fall, a new study by Simon Fraser University researchers suggests that even the fastest reflexes among all animals are remarkably slow.

"Animals as small as shrews and as large as elephants are built out of the same building blocks of nerve and muscle," says Max Donelan, a professor of Biomedical Physiology and Kinesiology (BPK) and director of SFU's Locomotion Lab. "We sought to understand how these building blocks are configured in different sized animals, and how this limits their performance."

The study is published today in the *Proceedings of the Royal Society B.*

Since an animal's life can hinge on how quickly it can sense and respond to stimuli, the team set out to quantify the speed of the fastest reflex involved in the locomotion of terrestrial mammals, in animals ranging in size from minuscule shrews to massive elephants.

"Not surprisingly, we found that reflexes take a lot longer in large animals -- about 17 times longer than their smallest counterparts," says SFU postdoctoral researcher Heather More. "What was more interesting to us is that these delays are mostly offset by movement times that also increase with size -- relative delay is only twice as long in an elephant as in a shrew, putting large animals at only a slight disadvantage."

More says their findings have implications for all animals, no matter what their size. "When running quickly, all animals are challenged by their lengthy response times which comprise nearly all of their available movement time -- even the fastest reflex for the control of running is remarkably slow." She adds: "If a small animal puts its foot in a hole when sprinting, there is barely

enough time for it to adjust its motion while the foot is on the ground, and a large animal has no time at all -- it has to wait until the next step."

More puts these delays in context: "One component of response time, nerve conduction delay, is particularly long in large animals. To compare to engineered systems, it takes less time for an orbiting satellite to send a signal to earth than for an elephant's spinal cord to send a signal to its lower leg."

A different component delay -- the time for a nerve impulse to cross a single synapse in the spinal cord -- is relatively long for small animals and relatively short for large animals. "This synaptic delay is one measure of the time to think -- so large animals have lots of time to think about how to respond to a disturbance, whereas as small animals don't."

The researchers say this means small and large animals likely compensate for their relatively slow reflexes in different ways. "We suspect that small animals rely on pre-flexive control, where their bodies are built in such a way that they can reject disturbances like stepping in a hole without intervention from their nervous system," says Donelan.

"Large animals, on the other hand, may rely more on prediction to think ahead about the consequences of their movements and adjust accordingly."

Donelan's lab has carried out previous locomotion studies involving elephants, giraffes and even kangaroos. A founder of Bionic Power and one of the original inventors of the bionic energy harvester, his research over the years has garnered international attention.

Story Source:

Materials provided by **Simon Fraser University**. *Note: Content may be edited for style and length.*

Mammal forerunner that reproduced like a reptile sheds light on brain evolution -- ScienceDaily

Compared with the rest of the animal kingdom, mammals have the biggest brains and produce some of the smallest litters of offspring. A newly described fossil of an extinct mammal relative -- and her 38 babies -- is among the best evidence that a key development in the evolution of mammals was trading brood power for brain power.

The find is among the rarest of the rare because it contains the only known fossils of babies from any mammal precursor, said researchers from The University of Texas at Austin who discovered and studied the fossilized family. But the presence of so many babies -- more than twice the average litter size of any living mammal -- revealed that it reproduced in a manner akin to reptiles. Researchers think the babies were probably developing inside eggs or had just recently hatched when they died.

The study, published in the journal *Nature* on Aug. 29, describes specimens that researchers say may help reveal how mammals evolved a different approach to reproduction than their ancestors, which produced large numbers of offspring.

"These babies are from a really important point in the evolutionary tree," said Eva Hoffman, who led research on the fossil as a graduate student at the UT Jackson School of Geosciences. "They had a lot of features similar to modern mammals, features that are relevant in understanding mammalian evolution."

Hoffman co-authored the study with her graduate adviser, Jackson School Professor Timothy Rowe.

The mammal relative belonged to an extinct species of beagle-size plant-eaters called Kayentatherium wellesi that lived alongside dinosaurs about 185

million years ago. Like mammals, Kayentatherium probably had hair.

When Rowe collected the fossil more than 18 years ago from a rock formation in Arizona, he thought that he was bringing a single specimen back with him. He had no idea about the dozens of babies it contained.

Sebastian Egberts, a former graduate student and fossil preparator at the Jackson School, spotted the first sign of the babies years later when a grain-sized speck of tooth enamel caught his eye in 2009 as he was unpacking the fossil.

"It didn't look like a pointy fish tooth or a small tooth from a primitive reptile," said Egberts, who is now an instructor of anatomy at the Philadelphia College of Osteopathic Medicine. "It looked more like a molariform tooth (molar-like tooth) -- and that got me very excited."

A CT scan of the fossil revealed a handful of bones inside the rock. However, it took advances in CT-imaging technology during the next 18 years, the expertise of technicians at UT Austin's High-Resolution X-ray Computed Tomography Facility, and extensive digital processing by Hoffman to reveal the rest of the babies -- not only jaws and teeth, but complete skulls and partial skeletons.

The 3D visualizations Hoffman produced allowed her to conduct an in-depth analysis of the fossil that verified that the tiny bones belonged to babies and were the same species as the adult. Her analysis also revealed that the skulls of the babies were like scaled-down replicas of the adult, with skulls a tenth the size but otherwise proportional. This finding is in contrast to mammals, which have babies that are born with shortened faces and bulbous heads to account for big brains.

The brain is an energy-intensive organ, and pregnancy -- not to mention childrearing -- is an energy-intensive process. The discovery that Kayentatherium had a tiny brain and many babies, despite otherwise having much in common with mammals, suggests that a critical step in the evolution of mammals was trading big litters for big brains, and that this step happened later in mammalian evolution.

"Just a few million years later, in mammals, they unquestionably had big brains, and they unquestionably had a small litter size," Rowe said.

The mammalian approach to reproduction directly relates to human development -- including the development of our own brains. By looking back at our early mammalian ancestors, humans can learn more about the evolutionary process that helped shape who we are as a species, Rowe said.

"There are additional deep stories on the evolution of development, and the evolution of mammalian intelligence and behavior and physiology that can be squeezed out of a remarkable fossil like this now that we have the technology to study it," he said.

Funding for the research was provided by the National Science Foundation, The University of Texas Geology Foundation and the Jackson School of Geosciences.

A recipe for regenerating nerve fibers across complete spinal cord injury -- ScienceDaily

The adult mammalian body has an incredible ability to heal itself in response to injury. Yet, injuries to the spinal cord lead to devastating conditions, since severed nerve fibers fail to regenerate in the central nervous system. Consequently, the brain's electrical commands about body movement no longer reach the muscles, leading to complete and permanent paralysis.

But what if it were possible to bridge the gap in the severed spinal cord? What if it were possible to regenerate severed nerve fibers across spinal cord injury?

In a collaboration led by EPFL (Ecole polytechnique fédérale de Lausanne) in Switzerland and UCLA (University of California at Los Angeles) in the USA, scientists have now understood the underlying biological mechanisms required for severed nerve fibers to regenerate across complete spinal cord injury, bridging that gap in mice and rats for the first time.

Their recipe targets three components for nerve fiber growth to occur. Without one or the other, the recipe simply does not succeed in regenerating new axons in the spinal cord. This three-pronged recipe was designed to reproduce the conditions underlying the growth of nerve fibers during development, leading to a robust regeneration of severed nerve fibers through and beyond a complete spinal cord injury.

"Our aim was to replicate, in adults, the conditions that encourage the growth of nerve fibers during development," explains senior author Grégoire Courtine of EPFL. "We have understood the combinations of biological mechanisms that are necessary to enable severed nerve fiber regrowth across complete spinal cord injuries in adult mammals."

By analogy, if nerve fibers were trees, then the terminal branches of the axons can be viewed as the tree's branches. If the main branches of the tree are cut, little branches may sprout spontaneously along the remaining trunk of the tree. But the cut branches do not grow back.

The same is true for neurons in adults: new branches of severed axons can sprout and make connections above an injury, but the severed part of the axon does not regrow. The 3-pronged recipe uncovered by the scientists changes that, making it possible to regenerate entire axons.

"We've regrown forests of axons," adds Courtine.

To recreate the spatiotemporal conditions of a developing nervous system, the scientists deliver a sequence of growth factors, proteins or hormones, to fulfill the three essential parts of the recipe: reactivate the genetic program for axons to grow; establish a permissive environment for the axons to grow in; and a chemical slope that marks the path along which axons are encouraged to regrow. Within 4 weeks, the axons regrow by several millimeters.

The new axons are able to transmit electricity -- and thus neural signals -- across the lesion, but this regained connectivity is not enough to restore walking. The rodents remained paralyzed, as anticipated by the scientists, since new circuits are not expected to be functional without the support of rehabilitation strategies.

"We dissected the mechanistic requirements for axon regeneration in the spinal cord, but it doesn't translate into function," explains lead author Mark Anderson of EPFL and UCLA. "Now we need to investigate the requirements so that the axons make the appropriate connections with locomotor circuits below the injury. This will entail rehabilitation with electrical stimulation to integrate, tune and functionalize the new axons so that the rodents can walk again."

Speculating about applications in humans is still premature. For example, the first component of the recipe that stimulates the grown of neurons happens two weeks before injury, so for now, more research must be done for the recipe to be clinically translatable.

Story Source:

Materials provided by **Ecole Polytechnique Fédérale de Lausanne**. Original written by Hillary Sanctuary. *Note: Content may be edited for style and length.*

Unstoppable monster in the early universe: ALMA obtains most detailed view of distant starburst galaxy -- ScienceDaily

Astronomers obtained the most detailed anatomy chart of a monster galaxy located 12.4 billion light-years away. Using the Atacama Large Millimeter/submillimeter Array (ALMA), the team revealed that the molecular clouds in the galaxy are highly unstable, which leads to runaway star formation. Monster galaxies are thought to be the ancestors of the huge elliptical galaxies in today's universe, therefore these findings pave the way to understand the formation and evolution of such galaxies.

"One of the best parts of ALMA observations is to see the far-away galaxies with unprecedented resolution," says Ken-ichi Tadaki, a postdoctoral researcher at the Japan Society for the Promotion of Science and the National Astronomical Observatory of Japan, the lead author of the research paper published in the journal *Nature*.

Monster galaxies, or starburst galaxies, form stars at a startling pace; 1000 times higher than the star formation in our Galaxy. But why are they so active? To tackle this problem, researchers need to know the environment around the stellar nurseries. Drawing detailed maps of molecular clouds is an important step to scout a cosmic monster.

Tadaki and the team targeted a chimerical galaxy COSMOS-AzTEC-1. This galaxy was first discovered with the James Clerk Maxwell Telescope in Hawai`i, and later the Large Millimeter Telescope (LMT) in Mexico found an enormous amount of carbon monoxide gas in the galaxy and revealed its hidden starburst. The LMT observations also measured the distance to the galaxy, and found that it is 12.4 billion light-years (Note).

Researchers have found that COSMOS-AzTEC-1 is rich with the ingredients of stars, but it was still difficult to figure out the nature of the cosmic gas in

the galaxy. The team utilized the high resolution and high sensitivity of ALMA to observe this monster galaxy and obtain a detailed map of the distribution and the motion of the gas. Thanks to the most extended ALMA antenna configuration of 16 km, this is the highest resolution molecular gas map of a distant monster galaxy ever made.

"We found that there are two distinct large clouds several thousand light-years away from the center," explains Tadaki. "In most distant starburst galaxies, stars are actively formed in the center. So it is surprising to find off-center clouds."

The astronomers further investigated the nature of the gas in COSMOS-AzTEC-1 and found that the clouds throughout the galaxy are very unstable, which is unusual. In a normal situation, the inward gravity and outward pressure are balanced in the clouds. Once gravity overcomes pressure, the gas cloud collapses and forms stars at a rapid pace. Then, stars and supernova explosions at the end of the stellar life cycle blast out gases, which increase the outward pressure. As a result, the gravity and pressure reach a balanced state and star formation continues at a moderate pace. In this way star formation in galaxies is self-regulating. But, in COSMOS-AzTEC-1, the pressure is far weaker than the gravity and hard to balance. Therefore this galaxy shows runaway star formation and has morphed into an unstoppable monster galaxy.

The team estimated that the gas in COSMOS-AzTEC-1 will be completely consumed in 100 million years, which is 10 times faster than in other star forming galaxies.

But why is the gas in COSMOS-AzTEC-1 so unstable? Researchers do not have a definitive answer yet, but galaxy merger is a possible cause. Galaxy collision may have efficiently transported the gas into a small area and ignited intense star formation.

"At this moment, we have no evidence of merger in this galaxy. By observing other similar galaxies with ALMA, we want to unveil the relation between galaxy mergers and monster galaxies," summarizes Tadaki.

Story Source:

Humanmade mangroves could get to the 'root' of the problem for threats to coastal areas -- ScienceDaily

With threats of sea level rise, storm surge and other natural disasters, researchers from Florida Atlantic University's College of Engineering and Computer Science are turning to nature to protect humans from nature. They are developing innovative ways to guard coastlines and prevent scouring and erosion from waves and storms using bioinspired materials that mimic mangrove trees found along shores, rivers and estuaries in the tropics and subtropics. Growing from a tangle of roots that twist their way out of the mud, mangrove trees naturally protect shorelines, shelter coastal ecosystem habitats and provide important water filtration. In many cases, these roots trap sediments flowing down rivers and off the land, helping to stabilize the coastline.

Certain mangrove root systems even have the ability to dissipate tidal energy through unique hydrological flows and divert the energy of water in different directions reducing risk of coastal damage. Yet, to date, few studies have examined the fluid dynamics such as flow structure and drag force on mangrove roots.

For a study, published in the American Physical Society's journal, *Physical Review Fluids*, researchers singled out the red mangrove tree (*Rhizophora mangle*) from more than 80 different species of mangroves, because of its robust network of roots that can withstand extreme environmental conditions. The red mangrove provided the researchers with an ideal model for bioinspired shoreline applications.

"Because of their strong structures, mangroves have survived for more than 8,000 years," said Amirkhosro Kazemi, Ph.D., lead author of the study and a post-doctoral fellow in FAU's Department of Ocean and Mechanical Engineering , who was awarded a Link Foundation fellowship and is working

with Oscar Curet, Ph.D., co-author and an assistant professor in the department. "What is truly amazing about mangroves is that they can adjust to changes in rising sea levels by forming upward structures through a natural process of accumulating layers of mud carried by tides and other sources. It's their root system in particular that contributes to this resiliency and is what inspired us to research their complex hydrodynamics."

To better understand the mangrove tree's resilience and the fluid dynamics of its roots, Kazemi, Curet, and Keith Van de Riet, Ph.D., co-author and an assistant professor at the University of Kansas, modeled the complex mangrove roots as a network of circular cylinders called a patch. They performed a series of experiments varying key parameters such as length scale and porosity or flexibility. They used a water tunnel and flow visualization to determine how the diameter of the root, its flexibility and how porous the mangroves are affect the water. They studied the mangrove roots under different flow conditions to quantify how the flow structure would interact with the mangrove.

They looked at the effect of porosity and spacing measures between the roots, tested force and velocity in a water tunnel, and concurrently performed 2D flow visualization.

The researchers performed direct drag force measurements and high-resolution particle image velocimetry to characterize the complex unsteady wake structure posterior to the arrays of the patch, which represents a simplified mangrove root model.

Results from the study show that for rigid roots, the drag force varied linearly with patch diameter and spacing between the roots. For flexible roots, the researchers discovered that a decrease in stiffness increased both the patch drag and the wake deficit behind the patch in a similar fashion as increasing the blockage of the patch. They have introduced a new length-scale (effective diameter) based on the wake signature to characterize the drag coefficient exerted on the patch for different porosities. The effective diameter incorporates the patch porosity, arrangement and individual root diameter in the patch. The results have proven that the effective diameter of the patch decreases as the porosity increases, giving rise to the Strouhal number -- used in dimensional analysis that is a dimensionless number describing oscillating

flow mechanisms.

"With nearly 2.4 billion people worldwide living within 60 miles of an oceanic coast, this research is extremely important for vulnerable coastlines not just in Florida but across the globe," said Stella Batalama, Ph.D., dean of FAU's College of Engineering and Computer Science. "Improving our understanding of the hydrodynamics of mangrove roots will help to facilitate the incorporation of bioinspired mangrove-like structures that can be used for erosion control, coastal protection, and habitat reconstruction."

Although many low-lying areas have storm surge protection such as seawalls, these structures are expensive to build, cause their own set of environmental concerns, and obstruct the natural landscape. Information from this study has the potential to help scientists and engineers develop methods to design resilient bioinspired coastline structures. Natural shorelines are flexible, inexpensive, and adjustable, and the prototype the researchers have developed is scalable, smaller and simpler to use as well as more cost effective. Their systematic modeling provides the framework to engineer mangrove-like structures for coastal protection.

"Our findings could potentially be used to build artificial mangrove banks for coastal areas. For example, our experimental work could even be applied in a uniform tidal flow where water flows constantly as the result of sea level rise," said Kazemi. "We are currently working on a new model that will allow us to understand the flow in a more complex design."

The fate of plastic in the oceans: Experiment shows: Microplastics aggregate with natural particles -- ScienceDaily

The oceans contain large numbers of particles of biological origin, including, for example, living and dead plankton organisms and their faecal material. These so-called biogenic particles interact with each other and often form lumps, or scientifically correct aggregates, many of which sink down in the water column. In addition to these natural particles, large amounts of plastic particles with a size of less than five millimetres, i.e. microplastics, have been in the oceans for some time.

Although new microplastics are constantly entering the oceans and some types of plastic have a relatively low density and therefore drift at the water surface, the microplastics concentrations at the surface of the oceans are often lower than expected. In addition, microplastics have repeatedly been found in deep-sea sediments in recent years. What happens to the microplastics in the ocean surface layer? How do they get to great water depths? "Our hypothesis was that microplastics, together with the biogenic particles in the seawater, form aggregates that possibly sink into deeper water layers," explains Dr. Jan Michels, member of the Cluster of Excellence 'The Future Ocean' and lead author of the study, which was published in the international journal *Proceedings of the Royal Society B* today.

To test this hypothesis, the researchers conducted laboratory experiments with polystyrene beads featuring a size of 700 to 900 micrometres. The aggregation behaviour of the beads was compared in the presence and in the absence of biogenic particles. The experiments provided a clear result: "The presence of biogenic particles was decisive for the formation of aggregates. While microplastic particles alone did nearly not aggregate at all, they formed quite pronounced and stable aggregates together with biogenic particles within a few days," describes Prof. Dr. Anja Engel, head of the GEOMAR research group, in which the study was carried out. After twelve days, an

average of 73 percent of the microplastics were included in the aggregates.

"In addition, we assumed that biofilms that are present on the surface of the microplastics play a role in the formation of aggregates," explains Michels, who led the investigations during his time at GEOMAR and now works at Kiel University. Such biofilms are formed by microorganisms, typically bacteria and unicellular algae, and are relatively sticky. To investigate their influence on the aggregation, comparative experiments were conducted with plastic beads that were either purified or coated with a biofilm. "Together with biogenic particles, the biofilm-coated microplastics formed the first aggregates after only a few hours, much earlier and faster than the microplastics that were purified at the beginning of the experiments," says Michels. On average, 91 percent of the microplastics coated with biofilm were included in aggregates after three days.

"If microplastics are coated with a biofilm and biogenic particles are simultaneously present, stable aggregates of microplastics and biogenic particles are formed very quickly in the laboratory," summarises Michels. In many regions of the oceans, the presence of both numerous biogenic particles and biofilms on the microplastics is probably a typical situation. "This is why the aggregation processes that we observed in our laboratory experiments very likely also take place in the oceans and have a great influence on the transport and distribution of microplastics," explains Prof. Dr. Kai Wirtz, who works at the Helmholtz-Zentrum Geesthacht and was involved in the project. This could be further investigated in the future through a targeted collection of aggregates in the oceans and subsequent systematic analyses for the presence of microplastics.

Story Source:

Materials provided by **Helmholtz Centre for Ocean Research Kiel (GEOMAR)**. *Note: Content may be edited for style and length.*

Cold climates contributed to the extinction of the Neanderthals -- ScienceDaily

Climate change may have played a more important role in the extinction of Neanderthals than previously believed, according to a new study published in the journal, *Proceedings of the Natural Academy of Sciences*.

A team of researchers from a number of European and American research institutions, including Northumbria University, Newcastle, have produced detailed new natural records from stalagmites that highlight changes in the European climate more than 40,000 years ago.

They found several cold periods that coincide with the timings of a near complete absence of archaeological artefacts from the Neanderthals, suggesting the impact that changes in climate had on the long-term survival of Neanderthal man.

Stalagmites grow in thin layers each year and any change in temperature alters their chemical composition. The layers therefore preserve a natural archive of climate change over many thousands of years.

The researchers examined stalagmites in two Romanian caves, which revealed more detailed records of climate change in continental Europe than had previously been available.

The layers of the stalagmites showed a series of prolonged extreme cold and excessively dry conditions in Europe between 44,000 and 40,000 years ago. They highlight a cycle of temperatures gradually cooling, staying very cold for centuries to millennia and then warming again very abruptly.

The researchers compared these palaeoclimate records with archaeological records of Neanderthal artefacts and found a correlation between the cold periods -- known as stadials -- and an absence of Neanderthal tools.

This indicates the Neanderthal population greatly reduced during the cold periods, suggesting that climate change played a role in their decline.

Dr Vasile Ersek is co-author of the study and a senior lecturer in physical geography in Northumbria University's Department of Geography and Environmental Sciences. He explained: "The Neanderthals were the human species closest to ours and lived in Eurasia for some 350,000 years. However, around 40,000 years ago -- during the last Ice Age and shortly after the arrival of anatomically modern humans in Europe -- they became extinct.

"For many years we have wondered what could have caused their demise. Were they pushed 'over the edge' by the arrival of modern humans, or were other factors involved? Our study suggests that climate change may have had an important role in the Neanderthal extinction."

The researchers believe that modern humans survived these cold stadial periods because they were better adapted to their environment than the Neanderthals.

Neanderthals were skilled hunters and had learned how to control fire, but they had a less diverse diet than modern humans, living largely on meat from the animals they had successfully pursued. These food sources would naturally become scarce during colder periods, making the Neanderthals more vulnerable to rapid environmental change.

In comparison, modern humans had incorporated fish and plants into their diet alongside meat, which supplemented their food intake and potentially enabled their survival.

Dr Ersek said the research team's findings had indicated that this cycle of "hostile climate intervals" over thousands of years, in which the climate varied abruptly and was characterised by extreme cold temperatures, was responsible for the future demographic character of Europe.

"Before now, we did not have climate records from the region where Neanderthals lived which had the necessary age accuracy and resolution to establish a link between when Neanderthals died out and the timing of these extreme cold periods," he said, "But our findings indicate that the

Neanderthal populations successively decreased during the repeated cold stadials.

"When temperatures warmed again, their smaller populations could not expand as their habitat was also being occupied by modern humans and this facilitated a staggered expansion of modern humans into Europe.

"The comparable timing of stadials and population changes seen in the archaeologic and genetic record suggests that millennial-scale hostile climate intervals may have been the pacesetter of multiple depopulation-repopulation cycles. These cycles ultimately drew the demographic map of Europe's Middle-Upper Paleolithic transition."

The more pesticides bees eat, the more they like them -- ScienceDaily

Bumblebees acquire a taste for pesticide-laced food as they become more exposed to it, a behaviour showing possible symptoms of addiction.

This study of bumblebee behaviour indicates that the risk of pesticide-contaminated food entering bee colonies may be higher than previously thought, which can have impacts on colony reproductive success.

In research published today in *Proceedings of the Royal Society B*, a team from Imperial College London and Queen Mary University of London (QMUL) have shown that bumblebee colonies increasingly feed on pesticide-laced food (sugar solution) over time.

The researchers tested the controversial class of pesticides the 'neonicotinoids', which are currently one of the most widely used classes of pesticides worldwide, despite the near-total ban in the EU. The impact of neonicotinoids on bees is hotly debated, and the ban is a decision that has received mixed views.

Lead researcher Dr Richard Gill, from the Department of Life Sciences at Imperial, said: "Given a choice, naïve bees appear to avoid neonicotinoid-treated food. However, as individual bees increasingly experience the treated food they develop a preference for it.

"Interestingly, neonicotinoids target nerve receptors in insects that are similar to receptors targeted by nicotine in mammals. Our findings that bumblebees acquire a taste for neonicotinoids ticks certain symptoms of addictive behaviour, which is intriguing given the addictive properties of nicotine on humans, although more research is needed to determine this in bees."

The team tracked ten bumblebee colonies over ten days, giving each colony access to its own foraging arena in which bees could choose feeders that did

or did not contain a neonicotinoid.

They found that while the bees preferred the pesticide-free food to begin with, over time they fed on the pesticide-laced food more and visited the pesticide-free food less. They continued to prefer the pesticide-laced food even when the positions of the feeders were changed, suggesting they can detect the pesticide inside the food.

Lead author Dr Andres Arce, from the Department of Life Sciences at Imperial, said: "Many studies on neonicotinoids feed bees exclusively with pesticide-laden food, but in reality, wild bees have a choice of where to feed. We wanted to know if the bees could detect the pesticides and eventually learn to avoid them by feeding on the uncontaminated food we were offering.

"Whilst at first it appeared that the bees did avoid the food containing the pesticide, we found that over time the bumblebees increased their visits to pesticide-laden food. We now need to conduct further studies to try and understand the mechanism behind why they acquire this preference."

Dr Gill added: "This research expands on important previous work by groups at Newcastle and Dublin Universities. Here, we added a time dimension and allowed the bees to carry out more normal foraging behaviour, to understand the dynamics of pesticide preference. Together these studies allow us to properly assess the risks of exposure and not just the hazard posed.

"Whilst neonicotinoids are controversial, if the effects of replacements on non-target insects are not understood, then I believe it is sensible that we take advantage of current knowledge and further studies to provide guidance for using neonicotinoids more responsibly, rather than necessarily an outright ban."

Story Source:

Materials provided by **Imperial College London**. Original written by Hayley Dunning. *Note: Content may be edited for style and length.*

Getting to the roots of our ancient cousins' diet: The splay of tooth roots reveals how South African hominins, Australopithecus africanus and Paranthropus robustus, chewed their food -- ScienceDaily

Food needs to be broken down in the mouth before it can be swallowed and digested further. How this is being done depends on many factors, such as the mechanical properties of the foods and the morphology of the masticatory apparatus. Palaeoanthropologists spend a great deal of their time reconstructing the diets of our ancestors, as diet holds the key to understanding our evolutionary history. For example, a high-quality diet (and meat-eating) likely facilitated the evolution of our large brains, whilst the lack of a nutrient-rich diet probably underlies the extinction of some other species (e.g., *P. boisei*). The diet of South African hominins has remained particularly controversial however.

Using non-invasive high-resolution computed tomography technology and shape analysis the authors deduced the main direction of loading during mastication (chewing) from the way the tooth roots are oriented within the jaw. By comparing the virtual reconstructions of almost 30 hominin first molars from South and East Africa they found that *Australopithecus africanus* had much wider splayed roots than both *Paranthropus robustus* and the East African *Paranthropus boisei*. "This is indicative of increased laterally-directed chewing loads in *Australopithecus africanus*, while the two Paranthropus species experienced rather vertical loads," says Kornelius Kupczik of the Max Planck Institute for Evolutionary Anthropology.

Paranthropus robustus, unlike any of the other species analysed in this study, exhibits an unusual orientation, i.e. "twist," of the tooth roots, which suggests a slight rotational and back-and-forth movement of the mandible during chewing. Other morphological traits of the *P. robustus* skull support this

interpretation. For example, the structure of the enamel also points towards a complex, multidirectional loading, whilst their unusual microwear pattern can conceivably also be reconciled with a different jaw movement rather than by mastication of novel food sources. Evidently, it is not only what hominins ate and how hard they bit that determines its skull morphology, but also the way in which the jaws are being brought together during chewing.

The new study demonstrates that the orientation of tooth roots within the jaw has much to offer for an understanding of the dietary ecology of our ancestors and extinct cousins. "Perhaps palaeoanthropologists have not always been asking the right questions of the fossil record: rather than focusing on what our extinct cousins ate, we should equally pay attention to how they masticated their foods," concludes Gabriele Macho of the University of Oxford.

Molar root variation in hominins is therefore telling us more than previously thought. "For me as an anatomist and a dentist, understanding how the jaws of our fossil ancestors worked is very revealing as we can eventually apply such findings to the modern human dentition to better understand pathologies such as malocclusions," adds Viviana Toro-Ibacache from the University of Chile and one of the co-authors of the study.

Story Source:

Materials provided by **Max Planck Institute for Evolutionary Anthropology**. *Note: Content may be edited for style and length.*

Health News

Top stories featured on ScienceDaily's Health & Medicine, Mind & Brain, and Living Well sections.

- **Body clock link to steroids discovered** [周三, 05 9月 04:46]
  Scientists have discovered that the time of day influences the way mice respond to steroids. Researchers found that out of 752 genes which regulate lungs in mice, 230 genes work only in the day and 197 only at night.
- **No evidence that moral reminders reduce cheating behavior, replication effort concludes** [周三, 05 9月 04:46]
  Scientists report they were unable to reproduce the results of a well-known study showing that people are less likely to cheat on a task after making a list of the Ten Commandments.
- **Focused delivery for brain cancers** [周三, 05 9月 04:46]
  Medical researchers are working toward a more focused drug delivery system that could target tumors lodged in the brainstem, the body's most precious system.
- **Antioxidant reduces risk for second heart attack, stroke** [周三, 05 9月 04:46]
  Doctors have long known that in the months after a heart attack or stroke, patients are more likely to have another attack or stroke. Now, an article explains what happens inside blood vessels to increase risk -- and suggests a new way to treat it.
- **Hormone therapy can make prostate cancer worse, study finds** [周三, 05 9月 04:46]
  Scientists have discovered how prostate cancer can sometimes withstand and outwit a standard hormone therapy, causing the cancer to spread. Their findings also point to a simple blood test that may help doctors predict when this type of hormone therapy resistance will occur.
- **Why we stick to false beliefs: Feedback trumps hard evidence** [周三, 05 9月 03:03]
  Ever wonder why flat earthers, birthers, climate change and Holocaust deniers stick to their beliefs in the face of overwhelming evidence to the contrary? New findings suggest that feedback, rather than hard evidence, boosts people's sense of certainty when learning new things or trying to tell right from wrong.
- **Superbug discovery renews hope for antibiotic treatment** [周三, 05 9月 02:06]
  Bacteria that were thought to be resistant to a powerful antibiotic may be susceptible to treatment after all, research has found.

- **Dementia symptoms peak in winter and spring, study finds** [周三, 05 9月 02:06]
  Adults both with and without Alzheimer's disease have better cognition skills in the late summer and early fall than in the winter and spring, according to a new study.
- **What could have extended human lifespan? Researchers identify 25 genetic changes** [周三, 05 9月 02:06]
  A new method has made it possible to identify 25 parallel mutations located in genes associated with wound healing, blood coagulation and cardiovascular disorders. The results could help to develop new drugs to treat aging-related diseases. The research confirms the theory that some genes that help us in the initial stages of life are harmful to us once the reproductive stage has ended.
- **Patients want more information about their medicines, study finds** [周三, 05 9月 02:05]
  Many patients want more information on the medicines they're prescribed and greater say in the brands they use, the first major study of the burden of long-term medicine use has concluded.
- **Novel strategy shows promise for earlier detection of Alzheimer's disease** [周三, 05 9月 02:05]
  Finding an effective way to identify people with mild cognitive impairment who are most likely to go on to develop Alzheimer's disease has eluded researchers for years. But now, a team of researchers has devised a novel strategy that could do just that.
- **Earlier diagnosis, potential therapy for Huntington's disease suggested in new research** [周三, 05 9月 02:05]
  A new study suggests that Huntington's disease may take effect much earlier in life than was previously believed, and that a new drug may be key in controlling the disease.
- **Hormone link between diabetes and hypertension identified** [周三, 05 9月 02:05]
  Increased levels of the hormone aldosterone, already associated with hypertension, can play a significant role in the development of diabetes, particularly among certain racial groups, researchers report.
- **AI beats doctors at predicting heart disease deaths** [周三, 05 9月 02:05]
  A model developed using artificial intelligence is better at predicting risk of death in patients with heart disease than models designed by medical experts, a new study shows.
- **DNA technology provides novel strategy for delivery of complex anti-HIV agent** [周三, 05 9月 02:05]
  Scientists have applied synthetic DNA technology to engineer a novel eCD4-Ig anti-HIV agent and to enhance its potency in vivo, providing a new simple strategy for constructing complex therapeutics for infectious agents as well as for diverse implications in therapeutic delivery.

- **You act most like 'you' in a time crunch, study finds** [周三, 05 9月 02:05]
  When they must act quickly, selfish people are likely to act more selfishly than usual, while pro-social people behave even more pro-socially, a new study found.
- **Attention network plays key role in restoring vision after brain damage** [周二, 04 9月 23:47]
  About one-third of patients who have suffered a stroke end up with low vision, losing up to half of their visual field. This partial blindness was long considered irreversible, but recent studies have shown that vision training after optic nerve and brain damage can help restore or improve vision. A new study reports on key mechanisms of vision restoration: attention.
- **Severely traumatized refugees may not necessarily develop PTSD** [周二, 04 9月 23:47]
  Heavily traumatized people such as refugees fleeing war, torture and natural catastrophes may not necessarily develop posttraumatic stress disorder (PTSD), a new study reveals.
- **Individual metering of heating consumption could lead to savings of up to 20 percent** [周二, 04 9月 23:47]
  Researchers have conducted a detailed study of the changes in habits brought about by individual metering and charging of heating and domestic hot water in a community of residents.
- **Breaking osteoporosis: New mechanism activates bone-building cells** [周二, 04 9月 23:47]
  The number of osteoporosis medications that promote bone formation are few compared to those that suppress bone resorption. Researchers have discovered that the gene SIRT7 is important for bone formation, and have succeeded in finding a new mechanism to activate gene functions essential for bone formation.
- **Simulations reveal role of calcium in titanium implant acceptance** [周二, 04 9月 23:47]
  Titanium-based materials are widely used in medical implant technology, and coating the surface of titanium materials with biologically active molecules has recently shown promise to improve how cells adhere to implants. The mechanisms behind how peptides stick to titanium, however, are not fully understood. Researchers have now found how calcium ions present at the interface between titanium oxide and tissues affect how well peptides bind to the metal.
- **Key differences between the exercise-trained heart and failing heart** [周二, 04 9月 23:47]
  Scientists have examined what is happening to the lipids in the heart and circulating blood plasma during exercise compared to a failing heart as a novel way to advance prediction and treatment of heart failure.
- **New clues found to understanding relapse in breast cancer** [周二, 04 9月 23:47]

A large genomic analysis has linked certain DNA mutations to a high risk of relapse in estrogen receptor positive breast cancer, while other mutations were associated with better outcomes, according to researchers.

- **New mechanism for how ALS disease evolves** [周二, 04 9月 23:47]
  Researchers have found a mechanism for how amyotrophic lateral sclerosis (ALS) evolves. The discovery concerns how proteins with a defect structure spread the deformation to other proteins.

- **Increased chances of successful IVF with 18-20 eggs** [周二, 04 9月 22:32]
  The likelihood of childbirth after in vitro fertilization (IVF) treatment increases if 18 to 20 eggs are stimulated to mature in a woman's ovaries, new research shows. That is more eggs than the number aimed at in today's IVF treatments.

- **Body temperature regulation: How fever comes** [周二, 04 9月 22:32]
  Researchers performed a microdialysis study on mice to determine mechanisms underlying the inflammatory response in the brain associated with fever that might be used to develop new strategies for treatment.

- **Like a zipper -- how cells form new blood vessels** [周二, 04 9月 22:32]
  Blood vessel formation relies on the ability of vascular cells to move while remaining firmly connected to each other. This enables the vessels to grow and sprout without leaking any blood. Scientists now describe how this works. In this process, the cytoskeleton pushes the cell forward, while an adhesion protein subsequently closes the gap to the neighboring cell, like a zipper.

- **Anti-inflammatory use during surgery could improve cancer outcomes** [周二, 04 9月 22:32]
  The world's first clinical trial (SURGUVANT) evaluating anti-inflammatory use at the time of surgery in colon cancer patients to improve their cancer outcome.

- **Induced changes to political attitude can last over time** [周二, 04 9月 22:30]
  Cognitive scientists have demonstrated that experimentally induced changes in political attitudes can last over time. Notably, participants who verbally motivated these 'false attitudes' exhibited the largest changes. This is the first time a lasting effect of the choice blindness phenomenon has been observed.

- **Concussions loosen insulation around brain cells** [周二, 04 9月 22:12]
  Detailed scans of concussed hockey players found that the protective fatty tissue surrounding brain cell fibers was loosened two weeks after the injury -- even though the athletes felt fine and were deemed ready to return to the ice. A loosening of that insulation, called myelin, slows the transmission of electrical signals between neurons, and shows that passing a concussion test may not be a reliable indicator of whether the brain has truly healed.

- **Internet and telephone assisted training for child**

disruptive behavior found to be effective [周二, 04 9月 22:12]
Positive long-term outcomes, such as a reduction in child disruptive behavior and increased parental skills, have been reported in a new study.

- **Mouse models may not accurately mimic severity of gonorrhea infection** [周二, 04 9月 21:38]
  The mouse model may not fully reflect the severity of the infection and the types of immune responses seen in humans.

- **Improving operations for the brain's most malignant tumor** [周二, 04 9月 21:38]
  Neurosurgeons and scientists evaluated use of state-of-the-art optical technology built into commercial grade operating microscopes used in neurosurgery to detect the glow produced by adding the pro-drug 5-ALA to experimental malignant brain tumors. 5-ALA is approved for administration to patients to increase the detection of the margin of invading brain glioma tumors, and thereby allow for a wider or more extensive brain tumor removal. As the most important visualization tool in daily use for ne…

- **Brain scans could distinguish bipolar from depression** [周二, 04 9月 21:37]
  New research has found that neurons deep inside the brain could hold the key to accurately diagnosing bipolar disorder and depression.

- **Artificial cells are tiny bacteria fighters** [周二, 04 9月 21:37]
  Newly created artificial cells can kill bacteria.

- **Neuropsychiatric disorders: Dopamine study offers hope for improved treatments** [周二, 04 9月 20:51]
  New work sheds light on how dopamine receptors signal within cells, opening the door for more targeted -- and more tolerable -- therapeutics to treat an array of neuropsychiatric disorders.

- **Biophysics: Self-centered** [周二, 04 9月 20:51]
  Rod-shaped bacterial cells normally divide by constriction midway along their long axis. Physicists have developed a theoretical model to explain how Myxococcus xanthus localizes the plane of division to mid-cell.

- **How weight loss is linked to future health for older adults** [周二, 04 9月 20:51]
  A study evaluated information from the Study of Osteoporotic Fractures and looked specifically at health and weight for women who were over age 65. Reviewing more than 20 years' worth of data for study participants, the team of researchers had the chance to examine links between long-term weight gain/loss and health.

- **Natural 'breakdown' of chemicals predicts lung damage in 9/11 firefighters** [周二, 04 9月 20:20]

Abnormal levels of more than two dozen metabolites -- chemicals produced in the body as it breaks down fats, proteins and carbohydrates -- can reliably predict which Sept. 11 firefighters developed lung disease and which did not, a new analysis shows.

- **Study provides 10-year risk estimates for dementia, which may help with prevention in high-risk individuals who potentially could benefit from early targeted prevention** [周二, 04 9月 20:20]
  A Danish study provides 10-year absolute risk estimates for dementia specific to age, sex and common variation in the APOE gene, which may help identify high-risk individuals who potentially could benefit from early targeted prevention. The study is published in CMAJ (Canadian Medical Association Journal).

- **Targeted and population-based strategies both necessary for blood pressure control** [周二, 04 9月 03:29]
  Hypertension, or high blood pressure, is the leading risk factor for heart disease, and improvements in both targeted and population-based strategies for blood pressure control can lead to better prevention and control of hypertension, according to a review paper.

- **Patients with new-onset AFib after TAVR at highest risk for complications** [周二, 04 9月 03:29]
  Patients developing AFib after TAVR are at higher risk of death, stroke and heart attack compared to patients who already had AFib prior to the procedure, according to a new study.

- **Children born through IVF may have higher risk of hypertension** [周二, 04 9月 03:29]
  Children conceived through assisted reproductive technologies may be at an increased risk of developing arterial hypertension early in life, among other cardiovascular complications, according to a new study.

- **Can social media networks reduce political polarization on climate change?** [周二, 04 9月 03:29]
  Political bias often leads to polarization on topics like climate change. But a new study has shown that exposure to anonymous, bipartisan social networks can make a striking difference, leading both liberals and conservatives to improve their forecasting of climate-change trends.

- **Infants can distinguish between leaders and bullies, study finds** [周二, 04 9月 03:29]
  A new study finds that 21-month-old infants can distinguish between respect-based power asserted by a leader and fear-based power wielded by a bully.

- **Scientists engineer way to prevent immune response to gene therapy in mice** [周二, 04 9月 03:29]
  Researchers have demonstrated that gene therapy can be effective without causing a dangerous side

effect common to all gene therapy: an autoimmune reaction to the normal protein, which the patient's immune system is encountering for the first time.

- **Lack of social mobility more of an 'occupational hazard' than previously known** [周二, 04 9月 03:29]
  American workers' occupational status reflects that of their parents more than previously known, reaffirming more starkly that the lack of mobility in the United States is in large part due to the occupation of our parents.

- **Neutrophil nanosponges soak up proteins that promote rheumatoid arthritis** [周一, 03 9月 23:34]
  Engineers have developed neutrophil 'nanosponges' that can safely absorb and neutralize a variety of proteins that play a role in the progression of rheumatoid arthritis. Injections of these nanosponges effectively treated severe rheumatoid arthritis in two mouse models. Administering the nanosponges early on also prevented the disease from developing. The nanosponges are nanoparticles of biodegradable polymer coated with the cell membranes of neutrophils, a type of white blood cell.

- **Now we can see brain cells 'talk' and that will shed light on neurological diseases** [周一, 03 9月 22:17]
  Scientists have developed a way to see brain cells talk -- to actually see neurons communicate in bright, vivid color. The new lab technique is set to provide long-needed answers about the brain and neurological diseases such as Alzheimer's disease, schizophrenia and depression.

- **New research shows how children want their food served** [周一, 03 9月 22:17]
  Getting children to eat their food is a challenge for many parents and new research could help. It turns out that children have different preferences for how food should be arranged on the plate to make them want to eat it, depending on gender and age.

Body clock link to steroids discovered: Time of day influences the way mice respond to steroids -- ScienceDaily

Professor David Ray, from The University of Manchester, lead the research which found that out of 752 genes which regulate lungs in mice, 230 genes work only in the day and only 197 at night.

And in the liver, where doctors have long thought that steroids are influential for many side effects, 1,702 genes regulate the organ in the day and a mere 299 at night in mice.

The research could one day have important implications on the way steroids -- one of the most common drugs in medicine -- are prescribed.

Published in the *Journal of Clinical Investigation*, the study is funded by the Wellcome Trust and the National Institutes of Health in the United States.

When Reverb? -- a molecule that controls the time of day effect is removed, the liver flips its genes so that more genes are regulated at night than during the day.

The removal of Reverb? also seemed to have a protective effect against the build up of fat in the liver -- known as fatty liver.

And that, says Professor Ray, could be important as daytime genes regulate glucose metabolism whereas night genes regulate fat metabolism.

Fatty liver is common, leads to diabetes, and can result in serious liver damage, including cirrhosis, if it progresses.

Professor Ray said: "Steroids are the most potent anti-inflammatory agent known to medicine. They are widely used and are very effective and used to treat a wide range of conditions.

"We can't yet say that this research confirms that taking steroids at different times of the day will impact on things like side effects.

"But this is clearly an exciting advance in the way we understand how steroids work."

He added: "There are experimental drugs which have been targeting Reverb? in animals.

"But now we hope to move on to measuring effectiveness and side effects on human tissue."

Story Source:

Materials provided by **University of Manchester**. *Note: Content may be edited for style and length.*

No evidence that moral reminders reduce cheating behavior, replication effort concludes -- ScienceDaily

Scientists report they were unable to reproduce the results of a well-known study showing that people are less likely to cheat on a task after making a list of the Ten Commandments. Their findings are published in a Registered Replication Report (RRR) in *Advances in Methods and Practices in Psychological Science*, a journal of the Association for Psychological Science.

The RRR, led by Bruno Verschuere from the University of Amsterdam and Ewout Meijer from the University of Maastricht, presented primary analyses of data from a total of 4,674 participants collected by 19 participating labs. The RRR aimed to replicate a 2008 study in which researchers Nina Mazar, On Amir, and Dan Ariely asked participants to recall either the Ten Commandments or 10 books they had read before completing a separate problem-solving task.

Data from the original study indicated that participants who had thought about the Ten Commandments, a moral reminder, were less likely to exaggerate when self-reporting how many problems they had solved compared with those who had been prompted to think about books. The findings provided support for self-concept maintenance theory, which holds that people seek personal gain so long as they can maintain a positive self-image while doing so.

Verschuere and Meijer developed the RRR protocol in consultation with Mazar, Amir, and Ariely, who provided the materials used in the original study and feedback on the study design. The protocol was preregistered and made publicly available online -- data from participating research teams were included in RRR analyses as long as the teams followed the protocol and met the preregistered criteria for inclusion.

The RRR data showed that the moral reminder had no observable effect on cheating behavior for participants who self-reported their problem-solving performance. Among the participants who had the opportunity to cheat, those who were asked to list the Ten Commandments reported solving about 0.11 more problems than their peers who listed books they had read. This stands in contrast with findings from the original study, which showed that participants who had thought about the Ten Commandments reported solving 1.45 fewer problems than their peers.

Although the participating research teams were located in various countries (including the US), there was little variation in their findings. This suggests that the features of the individual replication attempts and participants are unlikely to explain the overall RRR finding.

However, there may be other factors that could explain the divergent results.

"There are always differences between an original study and replication research. You cannot step in the same river twice," says Verschuere. "For instance, the original study was conducted more than a decade ago at an elite university. The perceived rewards, the perceived probability of getting caught and the perceived consequences of getting caught may have been different for participants in our replication study. But we also need to consider the possibility that the effect does not exist, and that the original result was a chance finding."

In a commentary accompanying the RRR, Amir, Mazar, and Ariely write that they are "grateful for the continued investigation and inquiry into a topic that we believe is not only important but also highly relevant in today's world."

They note that there are several possible reasons why the results detailed in the RRR might diverge from those of the original study, including the smaller testing group sizes. Also, participants may simply be more aware of research on dishonesty compared with those who participated in the original study a decade ago, they said.

According to Verschuere, the results show the importance of replication research.

"The psychological theory of cheating is very appealing, but we need more replication research to establish the reliability of its empirical basis," he concludes.

Focused delivery for brain cancers: Imaging, aerosols and pediatric neuro oncology come together to fight tumors -- ScienceDaily

A person's brainstem controls some of the body's most important functions, including heart beat, respiration, blood pressure and swallowing. Tumor growth in this part of the brain is therefore twice as devastating. Not only can such a growth disrupt vital functions, but operating in this area is so risky, many medical professionals refuse to consider it as an option.

New, interdisciplinary research in Washington University in St. Louis has shown a way to target drug delivery to just that area of the brain using noninvasive measures, bolstered by a novel technology: focused ultrasound.

The research comes from the lab of Hong Chen, assistant professor of biomedical engineering in the School of Engineering & Applied Science and assistant professor of radiation oncology at Washington University School of Medicine. Chen has developed a novel way in which ultrasound and its contrast agent -- consisting of tiny bubbles -- can be paired with intranasal administration, to direct a drug to the brainstem.

The research, which also included faculty from the Mallinckrodt Institute of Radiology and the Department of Pediatrics at the School of Medicine, along with the Department of Energy, Environmental & Chemical Engineering in the School of Engineering & Applied Science, was published online this week and will be in the Sept. 28 issue of the *Journal of Controlled Release*.

This technique may bring medicine one step closer to curing brain-based diseases such as diffuse intrinsic pontine gliomas (DIPG), a childhood brain cancer with a five-year survival rate of a scant two percent, a dismal prognosis that has remained unchanged over the past 40 years. (To add

perspective, the most common childhood cancer, acute lymphoblastic leukemia, has a five-year survival rate of nearly 90 percent).

"Each year in the United States, there are no more than 300 cases," Chen said. "All pediatric diseases are rare; luckily, this is even more rare. But we cannot count numbers in this way, because for kids that have this disease and their families, it is devastating."

Chen's technique combines Focused UltraSound with IntraNasal delivery, (FUSIN). The intranasal delivery takes advantage of a unique property of the olfactory and trigeminal nerves: they can carry nanoparticles directly to the brain, bypassing the blood brain barrier, an obstacle to drug delivery in the brain.

This unique capability of intranasal delivery was demonstrated last year by co-authors Ramesh Raliya, research scientist, and Pratim Biswas, assistant vice chancellor and chair of the Department of Energy, Environmental & Chemical Engineering and the Lucy & Stanley Lopata Professor, in their 2017 publication in Scientific Reports.

"At the beginning, I couldn't even believe this could work," Hong said of delivering drugs to the brain intranasally. "I thought our brains are fully protected. But these nerves actually directly connect with the brain and provide direct access to the brain."

While nasal brain drug delivery is a huge step forward, it isn't yet possible to target a drug to a specific area. Chen's targeted ultrasound technique is addressing that problem.

When doing an ultrasound scan, the contrast agent used to highlight images is composed of microbubbles. Once injected into the bloodstream, the microbubbles behave like red blood cells, traversing the body as the heart pumps.

Once they reach the site where the ultrasound wave is focused, they do something unusual.

"They start to expand and contract," Chen said. As they do so, they act as a

pump to the surrounding blood vessels as well as the perivascular space -- the space surrounding the blood vessels.

"Consider the blood vessels like a river," Chen said. "The conventional way to deliver drugs is to dump them in the river." In other parts of the body, the banks of the river are a bit "leaky," Chen said, allowing the drugs to seep into the surrounding tissue. But the blood brain barrier, which forms a protective layer around blood vessels in the brain, prevents this leakage, particularly in the brains of young patients, such as those with with DIPG.

"We will deliver the drug from the nose to directly outside the river," Chen said, "in the perivascular space."

Then, once ultrasound is applied at the brain stem, the microbubbles will begin to expand and contract. The oscillating microbubbles push and pull, pumping the drug toward the brainstem. This technique also addresses the problem of drug toxicity -- the drugs will go directly to the brain instead of circulating through the whole body. In collaboration with Yongjian Liu, an associate professor of radiology, and Yuan-Chuan Tai, an associate professor of radiology, Chen used positron emission tomography (PET scan) to verify that there was minimal accumulation of intranasal-administered nanoparticles in major organs, including lungs, liver, spleen, kidney and heart.

So far, Chen's lab has had success using their technique in mice for the delivery of gold nanoclusters made by the team led by Liu.

"The next step is to demonstrate the therapeutic efficacy of FUSIN in the delivery of chemotherapy drugs for the treatment of DIPG," said Dezhuang Ye, lead author of the paper, who is Chen's graduate student from the Department of Mechanical Engineering & Materials Science. The lab has also teamed up with Biswas to develop a new aerosol nasal delivery device to scale up the technique from a mouse to a large animal model.

Chen's lab collaborated on this research with pediatric neuro-oncologist Joshua Rubin, MD, PhD, a professor of pediatrics at the School of Medicine who treats patients at St. Louis Children's Hospital. Chen said the team hopes to translate the findings of this study into clinical trials for children with DIPG.

There are difficulties ahead, but Chen believes researchers will need to continue to innovate when it comes to solving such a difficult problem as treating DIPG.

A targeted inspiration

Hong Chen's lab collaborated with Joshua Rubin, MD, PhD, a professor of pediatrics at the School of Medicine on this research. And it all started with a couple of colleagues talking one day:

"My work in this field started with a conversation with him," Chen said. "He said, 'Wow, this would be a perfect technique for treating this deadly disease.' Without him to point me in this direction, I probably wouldn't have known this application existed.

"That's why I consider the Washington University environment, and the School of Engineering & Applied Science, so unique. It provides you so much opportunity to work with people from different backgrounds. It allowed me to expand my research scope and to be able to work on clinically relevant questions."

Antioxidant reduces risk for second heart attack, stroke: Cells and platelets stick inside arteries, increase risk after initial attack -- ScienceDaily

Doctors have long known that in the months after a heart attack or stroke, patients are more likely to have another attack or stroke. Now, a paper in the *Journal of the American College of Cardiology* explains what happens inside blood vessels to increase risk -- and suggests a new way to treat it.

Heart attacks in mice caused inflammatory cells and platelets to more easily stick to the inner lining of arteries throughout the body -- and particularly where there was already plaque, according to the paper. As a result, these sticky cells and platelets caused plaque to become unstable and contribute to blood clots that led to another heart attack or stroke.

But the study found treating mice that had experienced a heart attack or stroke with the powerful antioxidant apocynin cut plaque buildup in half and lowered inflammation to pre-attack levels.

"Knowing that newer forms of antioxidants such as apocynin can lower the risk of a second heart attack or stroke gives us a new treatment to explore and could one day help reduce heart attacks and strokes," said the paper's corresponding author, Jonathan R. Lindner, M.D., a professor of cardiovascular medicine at the OHSU School of Medicine.

Lindner penned the research paper with colleagues from OHSU, Scripps Research Institute and Bloodworks NW.

The researchers discovered the sticky cells and platelets by using unique forms of ultrasound imaging they developed to view molecules on the lining of blood vessels.

This research could help explain why the recent Canakinumab Anti-inflammatory Thrombosis Outcomes Study, also known as the CANTOS clinical trial, found an anti-inflammatory drug already approved to treat juvenile arthritis also reduced the risk of a second heart attack in trial participants by 15 percent.

Lindner and his colleagues are further studying how the relative stickiness of remote arteries affects the risks for additional heart attacks and strokes and are also evaluating new therapies beyond antioxidants.

The study was supported by the National Institutes of Health (R01-HL078610, R01-HL130046, R01-HL091153, R01-HL11763, HL42846, HL78784), NASA (grant 14-14NSBRI1-0025) and the Swiss National Science Foundation.

Story Source:

Materials provided by **Oregon Health & Science University**. *Note: Content may be edited for style and length.*

Hormone therapy can make prostate cancer worse, study finds -- ScienceDaily

Scientists at Cedars-Sinai have discovered how prostate cancer can sometimes withstand and outwit a standard hormone therapy, causing the cancer to spread. Their findings also point to a simple blood test that may help doctors predict when this type of hormone therapy resistance will occur.

Prostate cancer is the second-leading cause of cancer death in men, behind lung cancer, killing nearly 30,000 in the U.S. each year, according to the American Cancer Society. In its early stages, the most common type, adenocarcinoma, is curable and generally responds well to therapies, including those that target androgen -- a male sex hormone that stimulates tumor growth.

However, in certain patients, the cancer becomes resistant to androgen-targeted therapy, and the cancer recurs or spreads. One possible reason for that resistance, the study indicated, appears to be that the therapy causes some adenocarcinoma cells to become neuroendocrine cancer-type cells -- a rare type that normally appears in fewer than 1 percent of prostate cancer patients.

"This transformation is a problem because neuroendocrine prostate cancer is especially aggressive, metastasizes more readily and is more resistant to both androgen-targeted therapy and chemotherapy," said Neil Bhowmick, PhD, co-director of the Cancer Biology Program at the Samuel Oschin Comprehensive Cancer Institute at Cedars-Sinai. He is senior author of the study, published in the *Journal of Clinical Investigation*, and Rajeev Mishra, PhD, former project scientist in his laboratory, is the lead author.

Bhowmick said about one-fourth of the patients who receive androgen-targeted therapy may relapse with tumors that show features of neuroendocrine prostate cancer and develop treatment-resistant disease, according to published research.

To learn more about this process, the investigators examined how cancer cells interact with the supporting cells near the tumor, referred to as the tumor microenvironment, in laboratory mice. They found these interactions raised the level of the amino acid glutamine, turning the supporting cells into "factories" that supplied fuel for the cancer cells.

"While glutamine is known to spur cancer growth, its role in prostate cancer cells to trigger reprogramming of adenocarcinoma cells into neuroendocrine cancer cells is a new and important finding," said Roberta Gottlieb, MD, professor of Medicine and vice chair of translational medicine in the Department of Biomedical Sciences at Cedars-Sinai. Gottlieb was a co-author of the study.

The team also examined how androgen-targeted therapy affected the cancer microenvironment.

"To our surprise, we found this type of therapy further changed the cellular environment in a way that caused adenocarcinoma cells in the prostate to transform into neuroendocrine cancer-type cells," said Bhowmick, professor of Medicine and Biomedical Sciences.

As the final step in validating the findings in mice, investigators compared levels of glutamine in the plasma of small groups of patients -- one with treatment-responsive prostate cancer and the other with treatment-resistant prostate cancer. They found that levels of glutamine were higher in the second group.

This finding has potential implications for treating prostate cancer patients, said Edwin Posadas, MD, co-director of the Translational Oncology Program at the cancer institute and associate professor and clinical chief of the Division of Hematology/Oncology in the Department of Medicine at Cedars-Sinai.

"The study raises the possibility that a simple blood test measuring glutamine might be able to pinpoint when androgen-targeted therapy is failing in a prostate cancer patient and even predict when therapy resistance will occur," said Posadas, who co-authored the study. He said the team is designing a new study to test this hypothesis.

Funding: Research reported in this publication was supported by the National Cancer Institute of the National Institutes of Health under award numbers CA 108646 and CA 098912 and the U.S. Department of Veterans Affairs under award number BX001040.

Why we stick to false beliefs: Feedback trumps hard evidence: New study finds that feedback rather than hard evidence makes us more confident that we're right -- ScienceDaily

Ever wonder why flat earthers, birthers, climate change and Holocaust deniers stick to their beliefs in the face of overwhelming evidence to the contrary?

New findings from researchers at the University of California, Berkeley, suggest that feedback, rather than hard evidence, boosts people's sense of certainty when learning new things or trying to tell right from wrong.

Developmental psychologists have found that people's beliefs are more likely to be reinforced by the positive or negative reactions they receive in response to an opinion, task or interaction, than by logic, reasoning and scientific data.

Their findings, published today in the online issue of the journal *Open Mind*, shed new light on how people handle information that challenges their worldview, and how certain learning habits can limit one's intellectual horizons.

"If you think you know a lot about something, even though you don't, you're less likely to be curious enough to explore the topic further, and will fail to learn how little you know," said study lead author Louis Marti, a Ph.D. student in psychology at UC Berkeley.

This cognitive dynamic can play out in all walks of actual and virtual life, including social media and cable-news echo chambers, and may explain why some people are easily duped by charlatans.

"If you use a crazy theory to make a correct prediction a couple of times, you can get stuck in that belief and may not be as interested in gathering more information," said study senior author Celeste Kidd, an assistant professor of psychology at UC Berkeley.

Specifically, the study examined what influences people's certainty while learning. It found that study participants' confidence was based on their most recent performance rather than long-term cumulative results. The experiments were conducted at the University of Rochester.

For the study, more than 500 adults, recruited online through Amazon's Mechanical Turk crowdsourcing platform, looked at different combinations of colored shapes on their computer screens. They were asked to identify which colored shapes qualified as a "Daxxy," a make-believe object invented by the researchers for the purpose of the experiment.

With no clues about the defining characteristics of a Daxxy, study participants had to guess blindly which items constituted a Daxxy as they viewed 24 different colored shapes and received feedback on whether they had guessed right or wrong. After each guess, they reported on whether or not they were certain of their answer.

The final results showed that participants consistently based their certainty on whether they had correctly identified a Daxxy during the last four or five guesses instead of all the information they had gathered throughout.

"What we found interesting is that they could get the first 19 guesses in a row wrong, but if they got the last five right, they felt very confident," Marti said. "It's not that they weren't paying attention, they were learning what a Daxxy was, but they weren't using most of what they learned to inform their certainty."

An ideal learner's certainty would be based on the observations amassed over time as well as the feedback, Marti said.

"If your goal is to arrive at the truth, the strategy of using your most recent feedback, rather than all of the data you've accumulated, is not a great tactic," he said.

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Superbug discovery renews hope for antibiotic treatment -- ScienceDaily

Bacteria that were thought to be resistant to a powerful antibiotic may be susceptible to treatment after all, research has found.

The food-poisoning bug Listeria was shown to respond to an antibiotic even though the bacteria carry genes that should make it highly resistant.

Scientists say the antibiotic -- called fosfomycin -- should be reconsidered as a treatment for life-threatening Listeria infections.

Early lab tests had indicated that fosfomycin fails to kill Listeria because the bacteria carry a gene that enables it to break down the drug.

Further studies, however, found that the drug was effective at killing Listeria in infected cells in the lab and in mice.

Genes that are only activated when the bacteria infect the body cancel out the effects of the drug-destroying gene, researchers at the University of Edinburgh found.

The findings suggest fosfomycin could prove to be a useful treatment for life-threatening Listeria cases despite these bacteria testing resistant based on laboratory tests, the researchers say.

Listeria infection -- also known as listeriosis -- is the most lethal food-borne disease known and is often fatal. It is caused by eating contaminated foods such as soft cheeses, smoked salmon, pates, meats and salads.

The infection is particularly deadly for those with weak immune systems, such as older people and newborns. It can also cause miscarriage.

These bacteria reproduce within the cells of the body and frequently affect the brain, which only certain medicines are able to treat. This limits the

treatment options for serious infections, and so fosfomycin may prove highly beneficial.

The study, published in the journal *PLOS Genetics*, was funded by Wellcome.

Professor Jose Vazquez-Boland, who led the research at the University of Edinburgh's Division of Infection Medicine, said: "Our study focused on Listeria, but this important discovery may be relevant for other species of bacteria too. It is encouraging that we may be able to repurpose existing drugs in the race against antibiotic resistance."

Story Source:

Materials provided by **University of Edinburgh**. *Note: Content may be edited for style and length.*

Dementia symptoms peak in winter and spring, study finds -- ScienceDaily

Adults both with and without Alzheimer's disease have better cognition skills in the late summer and early fall than in the winter and spring, according to a new study published this week in *PLOS Medicine* by Andrew Lim of Sunnybrook Health Sciences Centre and the University of Toronto, Canada, and colleagues.

There have been few previous studies concerning the association between season and cognition in older adults. In the new work, researchers analyzed data on 3,353 people enrolled in three different cohort studies in the U.S., Canada, and France. Participants had undergone neuropsychological testing and, for some participants, levels of proteins and genes associated with Alzheimer's disease were available.

The authors found that average cognitive functioning was higher in the summer and fall than the winter and spring, equivalent in cognitive effect to 4.8 years difference in age-related decline. In addition, the odds of meeting the diagnostic criteria for mild cognitive impairment or dementia were higher in the winter and spring (odds ratio 1.31, 95% CI: 1.10-1.57) than summer or fall. The association between season and cognitive function remained significant even when the data was controlled for potential confounders, including depression, sleep, physical activity, and thyroid status. Finally, an association with seasonality was also seen in levels of Alzheimer's-related proteins and genes in cerebrospinal fluid and the brain. However, the study was limited by the fact that each participant was only assessed once per annual cycle, and only included data on individuals from temperate northern-hemisphere regions, not from southern-hemisphere or equatorial regions.

"There may be value in increasing dementia-related clinical resources in the winter and early spring when symptoms are likely to be most pronounced," the authors say. "By shedding light on the mechanisms underlying the seasonal improvement in cognition in the summer and early fall, these

findings also open the door to new avenues of treatment for Alzheimer's disease."

Story Source:

Materials provided by **PLOS**. *Note: Content may be edited for style and length.*

What could have extended human lifespan? Researchers identify 25 genetic changes -- ScienceDaily

Senescence, or biological aging, refers to the general deterioration of an organism's physiological functions, leading to increased susceptibility to diseases and ultimately death. It is a complex process that involves many genes. Lifespans vary greatly across different animal species. Thus, for example, flies live for four weeks, horses for thirty years, whereas some hedgehogs may live for up to two centuries. Why is the range of lifespans in nature so broad? This is one of the basic and most intriguing questions faced by biologists.

Potentially, human beings can live for up to 120 years, whereas the species of some closer primates live for half that period. In order to explain the reasons behind these differences, researchers from the Institute of Evolutionary Biology (IBE), a mixed centre belonging to the Pompeu Fabra University (UPF) and the Spanish National Research Council (CSIC), in collaboration with scientists from the Centre for Genomic Regulation (CRG), the University of Bristol and the University of Liverpool, have identified some of the genes that may have been crucial in extending the life of our species, as well as that of primates with a longer lifespan. The study has been published in the *Molecular Biology & Evolution* journal and is featured on the front cover.

In this work, the researchers studied the genomes of seventeen primate species, including humans. From the standpoint of aging, primates are interesting because while they are very similar, there are major differences across the different species in terms of longevity. Hence, of all the species studied, only three ? humans and two macaques ? lived longer than the common ancestor, which proves that "they have undergone a relatively rapid process of lifespan evolution," explains Arcadi Navarro, ICREA research professor at the IBE and the study leader.

The genes of these three species were compared to those of the remaining fourteen species in order to detect the mutations present in those with a longer life. "This would constitute very suggestive evidence that these genes have helped to extend their lives," says Navarro, who is also Professor of the UPF and CRG collaborator. Following the comparison, twenty-five mutations were identified in genes associated with wound-healing, coagulation and a large number of cardiovascular conditions.

"The results are meaningful, because a flexible and adaptable control of coagulation mechanisms are required in species that live longer," explains Gerard Muntané, the study's leading author and a postdoctoral researcher at the IBE and at the Institut d'Investigació Sanitària Pere Virgili (IISPV). Moreover, adds Muntané, "they confirm the pleiotropy theory of aging," which proposes that "certain mutations may have different effects depending on life-stage: they help us in the early stages but damage us in later stages, once the reproductive stage has ended."

The authors suggest that the results could help to develop new therapeutic targets for treating aging-related diseases and to demonstrate the potential of an evolutionary approach to medicine.

Story Source:

Materials provided by **Center for Genomic Regulation**. *Note: Content may be edited for style and length.*

Patients want more information about their medicines, study finds -- ScienceDaily

Many patients want more information on the medicines they're prescribed and greater say in the brands they use, the first major study of the burden of long-term medicine use has concluded.

University of Kent pharmacy expert Professor Janet Krska carried out research into what makes long-term medicine use burdensome for patients and found that those taking the highest number of medicines for the most times a day experienced the greatest impact -- with many concerned about side effects.

Surprisingly however, the study also found that older patients felt using regular medicines was less burdensome than younger patients, even though they use more medicines.

The research revealed that over a quarter of those surveyed wanted more information about their medicines and greater say in the brands of medicines they use, with a similar proportion concerned about paying for medicines. Over half were concerned about long-term adverse effects. Around 11% were not satisfied with the effectiveness of their medicines, and between 10 and 16% agreed that their medicines caused interference with some aspect of their daily life.

Thirty per cent agreed that their life revolved around medicines and only around a quarter felt they could decide whether or not to use them. There were 16% who didn't feel their doctor listened to their opinion about medicines and 11% said that their doctor didn't take concerns about side effects seriously.

Professor Krska and two other researchers at the University's Medway School of Pharmacy developed a new questionnaire -- known as the Living with Medicines Questionnaire (LMQ) -- to measure medicine burden. Eight areas

were covered: relationships with health professionals, practical difficulties, interference with daily life, lack of effectiveness, side effects, general concerns, cost and lack of autonomy.

Professor Krska said: 'The drive to implement clinical guidelines is contributing to increasing medicines use across the country, but the impact of this on patients among healthcare professionals is not always considered. Our study suggests that it's time for this to change.'

Story Source:

Materials provided by **University of Kent**. *Note: Content may be edited for style and length.*

Novel strategy shows promise for earlier detection of Alzheimer's disease -- ScienceDaily

Finding an effective way to identify people with mild cognitive impairment who are most likely to go on to develop Alzheimer's disease has eluded researchers for years. But now, a team of researchers led by David Loewenstein, Ph.D., director of the Center for Cognitive Neuroscience and Aging (CNSA) and professor of psychiatry and behavioral sciences at the University of Miami Miller School of Medicine, has devised a novel strategy that could do just that.

The study, "Utilizing Semantic Intrusions to Identify Amyloid Positivity in Mild Cognitive Impairment," funded by the National Institute on Aging, was published in the September issue of *Neurology* and earlier online.

Along with study co-author Rosie E. Curiel, Psy.D., assistant professor of psychiatry and clinical neuropsychology, and their colleagues, Loewenstein studied 88 patients with amnestic mild cognitive impairment (aMCI). They identified 34 people in this cohort with underlying, prodromal Alzheimer's disease (AD) by history and amyloid positive scans. Amyloid-beta is an abnormal protein in the brain long associated with the development of AD.

Among the 54 aMCI participants negative for amyloid-beta, 29 were classified as having a clinical course suggestive of AD but suspected non-AD pathology or "SNAP." The remaining 25 amyloid negative patients had major depression, anxiety or other psychiatric disorders; cerebral infarctions; diffuse Lewy Body disease, or other non-AD neurologic conditions.

The investigators predicted those at greatest risk for AD using the Loewenstein-Acevedo Scales for Semantic Interference and Learning (LASSI-L), a tool developed at the University of Miami. The LASSI-L allowed researchers to uncover specific memory deficits that aligned with

imaging findings for abnormal brain amyloid accumulation.

"Developing more sensitive and effective measures to tap the earliest Alzheimer's changes in the brain is essential for providing earlier and more effective treatment, to better understand the neuropathology of the disease, and to monitor emerging interventions," said Loewenstein.

The LASSI-L measure is a novel "cognitive stress test" validated in both English and Spanish. Researchers ask patients to read 15 words. The words come from three categories -- fruits, musical instruments and articles of clothing -- of five words each. They ask participant to repeat the list of words, and then cue their recall by category. A second trial repeats this learning task and the cued recall to strengthen their recall.

Next researchers present a list of 15 different words from the same three categories. The patients are asked to recall these new words as a measure of "proactive semantic interference" (PSI). PSI occurs where there is interference in new learning based on previous learning and correlates with risk of developing AD.

Researchers also present the second word list a second time, and repeat the cued recall. This component of the LASSI-L measures how well people can recover from the proactive semantic interference. It's called failure to recover from PSI (frPSI) -- and a second indicator of AD risk.

A major finding outlined in the Neurology paper was that the amyloid-beta imaging-positive patients committed a significantly higher number of semantic intrusion errors -- specifically on the PSI and frPSI measures -- compared to the SNAP and other non-AD patients.

Traditional cognitive measures to identify AD risk do not include PSI or frPSI, so the LASSI-L may represent a specific, non-invasive test that could successfully differentiate true AD from SNAP, the researchers noted.

"The association of the LASSI-L with amyloid positivity makes it useful in the clinical evaluation of preclinical Alzheimer's disease and for appropriate recruitment for clinical and prevention trials," Loewenstein said. "This also provides an effective and inexpensive way of screening at-risk populations."

The research is ongoing. Curiel received a new federal grant to computerize the LASSI-L and other novel cognitive measures. In addition, current studies are underway to compare progression on the LASSI-L to brain biomarkers such as MRI, fMRI and PET scans, as well as new agents that assess pathology in the brain.

"We are assisting our national and international institutional partners in developing this cognitive stress test for their investigations and clinical practice," Loewenstein said. "It is a goal of our Center for Cognitive Neurosciences and Aging and the University of Miami Miller School of Medicine to be at the forefront of these efforts."

Earlier diagnosis, potential therapy for Huntington's disease suggested in new research -- ScienceDaily

"This could be a good start to developing new promising treatments for Huntington's disease, treatments that could be administered even before signs of the illness appear," said Alexander Osmand, researcher in the Department of Biochemistry and Cellular and Molecular Biology at the University of Tennessee, Knoxville, and coauthor of the study.

The disease, which causes the progressive deterioration of both mental and physical abilities, is the result of a genetic mutation of the huntingtin gene. All humans possess this gene, and studies suggest that is necessary to healthy development. Its mutated form, however, causes the rapid decay of specific neurons, eventually resulting in death.

Usually, the effects of Huntington's disease are not apparent until an adult reaches their 30s or 40s. By studying mice, however, researchers have discovered that an array of effects may be seen much earlier.

Although these early symptoms are less clearly defined than the later, more debilitating effects, they could serve as an indicator to health care providers that further screening may be needed.

Researchers subjected several litters of mice carrying the human huntingtin gene to four different dose regimens of Panobinostat, a drug currently used in the treatment of various cancers. Researchers believe that this drug can regulate gene expression, which could be an important step towards treating those with Huntington's disease.

The researchers also studied the mice's behavior by monitoring their vocalization, startle response, and risk-taking behavior. These behavioral abnormalities showed that symptoms of the disease were present prior to the

full mutation commonly associated with Huntington's.

Although treatment with Panobinostat cannot reverse gene mutation completely, clinical trials have shown that it may prevent gene changes associated with the expression of the disease. Until now doctors have been able to treat only some of the symptoms associated with Huntington's disease, such as depression, mood swings, and involuntary movement. While these treatments may make Huntington's easier to bear, they do nothing to combat the disease itself.

Approximately 30,000 Americans suffer from the disease, according to the Huntington's Disease Society of America, and one 2013 study found that treatment can cost anywhere from $4,947 to $37,495 annually depending on the severity of the condition.

Story Source:

Materials provided by **University of Tennessee at Knoxville**. *Note: Content may be edited for style and length.*

Hormone link between diabetes and hypertension identified -- ScienceDaily

Physician researchers with The Ohio State University College of Medicine at the Wexner Medical Center say increased levels of the hormone aldosterone, already associated with hypertension, can play a significant role in the development of diabetes, particularly among certain racial groups.

"This research is an important step toward finding new ways to prevent a major chronic disease," said Dr. K. Craig Kent, dean of the College of Medicine. "This shows how our diabetes and metabolism scientists are focused on creating a world without diabetes."

Results of this study were published online today by the *Journal of the American Heart Association*.

"Aldosterone is produced by the adrenal gland. We've known for some time that it increases blood pressure. We've recently learned it also increases insulin resistance in muscle and impairs insulin secretion from the pancreas. Both actions increase a person's risk of developing type 2 diabetes, but the question was -- how much," said Dr. Joshua J. Joseph, lead investigator and an endocrinologist at Ohio State Wexner Medical Center.

Joseph and his team followed 1,600 people across diverse populations for 10 years as part of the Multi-Ethnic Study of Atherosclerosis. They found, overall, the risk of developing type 2 diabetes more than doubled for people who had higher levels of aldosterone, compared to participants with lower levels of the hormone. In certain ethnicities, the effect was even greater. African Americans with high aldosterone levels have almost a three-fold increased risk. Chinese Americans with high aldosterone are 10 times more likely to develop diabetes.

"I looked into this as a promise to my father. He had high levels of aldosterone that contributed to his hypertension, and he thought it also might

be linked to his diabetes. As my career progressed, I had the opportunity to research it, and we did find a link to diabetes," Joseph said.

One question that remains is why there are wide differences in risk among various ethnic groups. Joseph said it could be genetics or differences in salt sensitivity or something else, and it needs further study.

Just over 30 million Americans have diabetes and nearly a fourth of them don't know it, according to the Centers for Disease Control and Prevention. Another one in three Americans has prediabetes. Despite current preventive efforts, the numbers continue to climb among various racial/ethnic groups.

Next, Joseph will lead a federally funded clinical trial at Ohio State Wexner Medical Center to evaluate the role of aldosterone in glucose metabolism. African American participants who have prediabetes will take medication to lower their aldosterone levels. Researchers will study the impact on blood glucose and insulin in those individuals.

"We know there's a relationship between aldosterone and type 2 diabetes. Now we need to determine thresholds that will guide clinical care and the best medication for treatment," Joseph said.

He expects to start enrolling patients in that trial later this year.

Story Source:

Materials provided by **The Ohio State University Wexner Medical Center**.
Note: Content may be edited for style and length.

AI beats doctors at predicting heart disease deaths -- ScienceDaily

A model developed using artificial intelligence (AI) is better at predicting risk of death in patients with heart disease than models designed by medical experts, a new study from the Francis Crick Institute shows.

The study, published in *PLOS One*, adds to the growing evidence that AI could revolutionise healthcare in the UK and beyond. So far, the emphasis has been on the potential of AI to help diagnose and treat various diseases, but these new findings suggest it could also help predict the likelihood of patients dying too.

"It won't be long before doctors are routinely using these sorts of tools in the clinic to make better diagnoses and prognoses, which can help them decide the best ways to care for their patients," says Crick scientist Andrew Steele, first author of the paper.

"Doctors already use computer-based tools to work out whether a patient is at risk of heart disease, and machine-learning will allow more accurate models to be developed for a wider range of conditions."

Data-driven model

The model was designed using the electronic health data of over 80,000 patients, collected as part of routine care, and available for researchers on the CALIBER platform.

Scientists at the Crick, working collaboratively with colleagues at the Farr Institute of Health Informatics Research and University College London Hospitals NHS Foundation Trust, wanted to see if they could create a model for coronary artery disease -- the leading cause of death in the UK -- that outperforms experts using self-taught machine learning techniques.

Coronary artery disease develops when the major blood vessels that supply the heart with blood, oxygen and nutrients become damaged, or narrowed by fatty deposits. Eventually restricted blood flow to the heart can lead to chest pain and shortness of breath, while a complete blockage can cause a heart attack.

An expert-constructed prognostic model for coronary artery disease which this work was compared against made predictions based on 27 variables chosen by medical experts, such as age, gender and chest pains. By contrast, the Crick team got their AI algorithms to train themselves, searching for patterns and picking the most relevant variables from a set of 600.

Outperforming experts

Not only did the new data-driven model beat expert-designed models at predicting patient mortality, but it also identified new variables that doctors hadn't thought of.

"Along with factors like age and whether or not a patient smoked, our models pulled out a home visit from their GP as a good predictor of patient mortality," says Andrew. "Home visits are not something a cardiologist might say is important in the biology of heart disease, but perhaps a good indication that the patient is too unwell to make it to the doctor themselves, and a useful variable to help the model make accurate predictions."

This study was a proof-of-principle to compare expert-designed models to machine learning approaches, but a similar model could be implemented in the clinic in the not too distant future.

"Machine learning is hugely powerful tool in medicine and has the ability to revolutionise how we deliver care to patients over the next few years," says Andrew.

Story Source:

Materials provided by **The Francis Crick Institute**. *Note: Content may be edited for style and length.*

DNA technology provides novel strategy for delivery of complex anti-HIV agent: DNA electroporation technology successfully used to direct expression of anti-HIV immunoadhesins and to modulate their function in vivo -- ScienceDaily

Scientists at The Wistar Institute have applied their synthetic DNA technology to engineer a novel eCD4-Ig anti-HIV agent and to enhance its potency in vivo, providing a new simple strategy for constructing complex therapeutics for infectious agents as well as for diverse implications in therapeutic delivery. This critical development was published online in the journal *EBio Medicine*.

The development of a safe and effective HIV vaccine has proven critically challenging. Researchers are exploring passive immunization of laboratory-produced immunoadhesins as well as traditional gene therapy methods for delivery of these complex therapeutic molecules. Immunoadhesins are designed antibody-like molecules specifically engineered to efficiently neutralize diverse forms of HIV by binding with high affinity to the virus envelope.

"These complex therapeutics are difficult to deliver through traditional strategies and achieving full activity in vivo using DNA technology is also challenging," said lead researcher David B. Weiner, Ph.D., executive vice president, director of the Vaccine & Immunotherapy Center and W.W. Smith Charitable Trust Professor in Cancer Research at The Wistar Institute. "We demonstrated that a combination of plasmids can be designed to produce a novel protein as well as its modifying enzyme, allowing them to collocate with each other and create a highly functional immunoadhesin."

Electroporation of synthetic DNA (DNA/EP) consists of the application of small, controlled directional electric currents into the skin or muscle to facilitate optimal uptake of DNA molecules and local production of the DNA-encoded proteins. Using this technology, Weiner and colleagues were able to achieve robust and long-term in vivo expression. A single injection of the synthetic DNA formulation produced functional eCD4-Ig for several months in a mouse model.

Previous studies have shown that a particular modification of the immunoadhesins, called sulfation, favors their binding to the HIV envelope; therefore, co-expression of the TPST2 enzyme that operates this modification is necessary to enhance the anti-HIV potency of the produced eCD4-Ig. The team proved the ability of synthetic DNA to encode the TPST2 enzyme as well as the instructions to direct the produced TPST2 to the cell compartment where the eCD4-Ig molecule is manufactured. The combined delivery resulted in production of sulfated eCD4-Ig immunoadhesin that exhibited enhanced potency.

"This is the first report on the use of synthetic DNA to encode an enzyme that can effectively carry out its activity and modulate biological functions of a target protein with high efficiency in vivo," said Weiner.

Collectively, these study results provide an important advancement for the field of HIV immunization and open the path to further applications for in vivo delivery of biologics.

This work was supported by the National Institutes of Health Integrated Preclinical/Clinical AIDS Vaccine Development Program (IPCAVD) grant U19 Al109646-04. Additional funding was provided by the Martin Delaney Collaboratory for HIV Cure Research and the W.W. Smith Charitable Trust Foundation.

Ziyang Xu from The Wistar Institute and Megan C. Wise from Inovio Pharmaceuticals, Inc., are first co-authors of this study. Other co-authors from Wistar include Hyeree Choi, Alfredo Perales-Puchalt, Ami Patel, Edgar Tello-Ruiz, Jacqueline D. Chu, and Kar Muthumani.

Story Source:

Materials provided by **The Wistar Institute**. *Note: Content may be edited for style and length.*

You act most like 'you' in a time crunch, study finds: Under time pressure, selfish people act even more selfishly -- ScienceDaily

When they must act quickly, selfish people are likely to act more selfishly than usual, while pro-social people behave even more pro-socially, a new study found.

The results suggest that when people don't have much time to make a decision, they go with what they've done in similar situations, said Ian Krajbich, co-author of the study and assistant professor of psychology and economics at The Ohio State University.

"People start off with a bias of whether it is best to be selfish or pro-social. If they are rushed, they'll tend to go with that bias," Krajbich said.

But when people have more time to decide, they are more likely to go against their bias as they evaluate the options in front of them, he said.

Krajbich conducted the study with Fadong Chen of Zhejiang University in China. Their results were published Sept. 3 in the journal *Nature Communications*.

The study involved 102 college students from the United States and Germany who played 200 rounds of a game that is often used in psychology and economics experiments. In each round, played on a computer, the participants chose between two ways of splitting up a real sum of money. Both choices favored the person playing the game, but one choice shared more of the money with the unseen partner.

"The participants had to decide whether to give up some of their own money to increase the other person's payoff and reduce the inequality between

them," Krajbich said.

The decision scenarios were very different. In some cases, the participants would have to give up only, say, $1 to increase their partner's payoff by $10. In others, they might have to give up $1 to give their partner an extra $1. And in other cases, they would have to make a large sacrifice -- for example, give up $10 to give their partner an extra $3.

The key to this study is that participants didn't always have the same amount of time to decide, Krajbich said.

In some cases, participants had to decide within two seconds how they would share their money as opposed to other cases, when they were forced to wait at least 10 seconds before deciding. And in additional scenarios, they were free to choose at their own pace, which was usually more than two seconds but less than 10.

The researchers used a model of the "normal" decisions to predict how a participant's decisions would change under time pressure and time delay.

"We found that time pressure tends to magnify the predisposition that people already have, whether it is to be selfish or pro-social," Krajbich said.

"Under time pressure, when you have very little time to decide, you're going to lean more heavily than usual on your predisposition or bias of how to act."

The situation was different when participants were forced to wait 10 seconds before deciding.

"People may still approach decisions with the expectation that they will act selfishly or pro-socially, depending on their predisposition. But now they have time to consider the numbers and can think of reasons to go against their bias," he said.

"Maybe you're predisposed to be selfish, but see that you only have to give up $1 and the other person is going to get $20. That may be enough to get you to act more pro-socially."

The results may help explain why some previous studies found that time pressure makes people more selfish, while others found that it makes people more pro-social.

"It really depends on where you're starting, on how you're predisposed to decide," Krajbich said.

Story Source:

Materials provided by **Ohio State University**. Original written by Jeff Grabmeier. *Note: Content may be edited for style and length.*

Attention network plays key role in restoring vision after brain damage: New study highlights the role of attention as a component of vision restoration training in hemianopia -- ScienceDaily

About one third of patients who have suffered a stroke end up with low vision, losing up to half of their visual field. This partial blindness was long considered irreversible, but recent studies have shown that vision training after optic nerve and brain damage can help restore or improve vision. A new study published in the journal *Clinical Neurophysiology* reports on key mechanisms of vision restoration: attention.

Hemianopia is a decreased vision or blindness in half the visual field, usually as a consequence of stroke or trauma to the brain. It greatly reduces quality of life, affecting patients' reading, driving and spatial navigation.

"Knowledge in this field is still rather fragmentary, but recent studies have shown that vision can be partially restored by vision training, which improves the deficient visual field sectors," explains Prof. Bernhard Sabel, PhD, Director of the Institute of Medical Psychology at Magdeburg University, Germany, co-investigator of the study. "Neuroimaging evidence supports a possible role of attention in this vision restoration."

The study confirmed this hypothesis by obtaining evidence from functional magnetic resonance imaging (fMRI) that visual training led to functional connectivity reorganization of the brain´s attentional network.

Seven chronic hemianopic patients with lesions of the visual cortex took part in vision rehabilitation training for five weeks. After the pre-tests all received training sessions lasting one and a half hours per day for six days per week for five weeks. Each training session, lasting about 60 minutes, was

composed of six blocks with 120 training trials each, during which participants had to respond to specially designed visual stimuli on a computer monitor. The pre- and post-test included perimetry testing, contrast sensitivity testing and fMRI scanning one or two days before and after training, respectively. Each contrast sensitivity test consisted of 420 trials in six blocks. The visual rehabilitation training was performed with one eye open, which was randomly chosen, while the non-trained eye was covered with an opaque eye patch.

After training, the patients had significantly improved visual function at the training location, and fMRI showed that the training led to a strengthening of the cortical attentional network connections between the brain region of the right temporoparietal junction (rTPJ) and the insula and the anterior cingulate cortex (ACC).

"Our MRI results highlight the role of attention and the right TPJ activation as a component of vision restoration training in hemianopia," notes lead investigator Yifeng Zhou, DSc, of the Hefei National Laboratory for Physical Sciences at Microscale and School of Life Science, University of Science and Technology of China, Hefei, P.R. China, and State Key Laboratory of Brain and Cognitive Science, Institute of Biophysics, Chinese Academy of Sciences, Beijing, P.R. China. "However, it is unclear whether the rehabilitation of attentional networks is the direct result of training or the result of the rebalancing of bottom-up sensory streams, which should be investigated in future studies."

"This discovery that the brain´s attention network is a key mechanism in partially reversing blindness is an exciting advance in the field of restoring vision in the blind, and it opens up new avenues to design new therapies that are even more effective than current methods to help people with low vision or blindness," concludes Prof. Sabel.

Severely traumatized refugees may not necessarily develop PTSD -- ScienceDaily

Heavily traumatized people such as refugees fleeing war, torture and natural catastrophes may not necessarily develop posttraumatic stress disorder (PTSD), a new study reveals.

Researchers worked with a group of refugees -- half suffering from PTSD, the others not -- and asked them to suppress neutral memories. Results showed that participants who struggled to control these thoughts were more likely to show symptoms of PTSD.

The research raises the question of whether the ability to control memories protects against developing PTSD or if the condition causes an impairment in an individual's ability to control their memories?

Experts at the University of Birmingham, Ruhr-Universität Bochum, the University of Konstanz and Berlin's Max Planck Institute for Human Development worked with 24 refugees from a range of European, African and Asian countries to complete the study, which is published in *Scientific Reports*.

They found that the more severe the PTSD symptoms, the more difficult refugees found suppressing neutral memories. Their study also indicated that efforts to forget the memories caused problems in remembering non-traumatic experiences.

The research indicates that PTSD patient's problems in suppressing traumatic memories relates to dysfunctional gamma frequency activity in the brain -- a discovery that could help to shape more effective treatments.

Dr Simon Hanslmayr, Reader in Cognitive Neuroscience at the University of Birmingham, commented: "Difficulties experienced by people with severe PTSD symptoms when attempting to suppress bad memories is linked to the

ability to regulate gamma frequency brain activity.

"This novel biomarker could help identify risks posed to PTSD patients by memory suppression techniques and assist in adapting and developing psychotherapeutic methods. Our study certainly raises concerns about unwary use of memory suppression in treating PTSD sufferers."

The researchers note that more research is needed into the effects of traumatic stress in refugees. This would help to develop effective medical strategies to deal with the immediate health and socioeconomic challenges posed by high numbers of refugees.

Dr Gerd Waldhauser, from the Institute of Cognitive Neuroscience at Ruhr University Bochum, commented: "Refugees and asylum seekers are often excluded from medical treatment or do not seek help. They are often unable or unwilling to take part in deamanding cognitive neuroscience studies, making data such as ours precious in understanding a rarely-studied population with abundant mental health problems."

PTSD is a disorder characterised by the recurrent and uncontrollable intrusion of traumatic memories. Patients tend to try to suppress these intrusions which can aggravate the condition's symptoms and cause further emotional distress.

Researchers worked with a group of 24 refugees, who took part in a series of tests whilst being observed with magnetoencephalography (MEG) brain imaging technology which registered the different frequencies of brain activity they exhibited.

Story Source:

Materials provided by **University of Birmingham**. *Note: Content may be edited for style and length.*

Individual metering of heating consumption could lead to savings of up to 20 percent -- ScienceDaily

Metering and charging on an individual basis of heating and hot water consumption is at varying levels of development in European countries. The 2012/27/EU Directive on energy efficiency published in 2012 stipulated the compulsory nature of implementing this kind of system across all member states. Despite the 2016 deadline laid down by the directive for the states to transpose the directive into their internal legislation, today "this has not been done here; right now, there is a draft Royal Decree by which the directive will be transposed, but it has yet to be passed," explained Jon Terés, a member of the ENEDI research group at the UPV/EHU's Faculty of Engineering -- Bilbao and one of the authors of this study.

Despite the fact that current legislation does not yet make this compulsory, "an attempt has been made by installation and maintenance companies and even property administrators to encourage individualisation in communities with centralised heating systems, in other words, those in which a heating and domestic hot water system, and cooling, where appropriate, is supplied to more than one end user. That is why there are more and more communities of residents that decide to go ahead with the installation, although the vast majority of buildings with centralised installations built before 1998 still do not have these systems," he said.

The ENEDI research group has conducted a detailed study of the savings to be made through the individualisation of the metering and charging of the heating and water consumed in a block of about 140 flats in Bilbao. As the researcher explained, the aim sought by this study was "to find out how much energy was being saved through this measure in temperate climates. Most of the studies of this type have been carried out in the north of Europe where climate conditions in winter are much harsher. We aimed to see the extent to which the results of these studies could be extrapolated to our climate, where

the winters are much milder."

In the study conducted they compared the community's heating oil consumption during the two years prior to the intervention with the consumption over the two years that followed. "The results revealed energy savings in the building studied of up to 20% during the period studied; these percentages of savings are very similar to those seen in publications focussing on the conditions in the north of Europe. What is more, in this particular case study, the payback period on investment would be about 10 years, perfectly manageable for systems of this type," specified Terés.

Greater control of and flexibility in consumption

The main difference resulting from consumption on an individual basis is that it allows greater flexibility in the use of the heating system and the possibility of adjusting it to the needs of each home; and when the users pay on the basis of consumption, they become more aware of their use of heating and domestic hot water. As a general rule, this awareness underpins the reduction in consumption in the homes in the block.

What happens in communities where consumption is not on an individual basis, is that "the residents are often unable to turn the system on and off, and the heating functions on the basis of what the community has agreed, following criteria with respect to the calendar and time of day, irrespective of whether the homes are occupied or not in that period, or the temperature that each user wants to have in his/her home; the scenario emerges of having the windows open in winter and the heating turned on," specified the researcher. Furthermore, the heating cost is shared out on the basis of criteria that have nothing to do with the consumption made, such as the number of square metres of each flat.

In view of the results, Terés believes that this case study constitutes "an interesting starting point for this type of study in temperate climates. Right now, we are working on the study of individual consumption, because there are some residents who save much more than others, and we would have to conduct the same study on a bigger number of blocks of flats and perhaps taking longer periods of time into consideration to be able to extrapolate and draw general conclusions from the results."

Story Source:

Materials provided by **University of the Basque Country**. *Note: Content may be edited for style and length.*

Breaking osteoporosis: New mechanism activates bone-building cells: On the road to developing new therapeutic drugs for osteoporosis and other bone degenerative diseases -- ScienceDaily

The number of osteoporosis medications that promote bone formation are few compared to those that suppress bone resorption. A research group led by Kumamoto University scientists has discovered that the gene SIRT7 is important for bone formation, and have succeeded in finding a new mechanism to activate gene functions essential for bone formation. The researchers expect that the 'SIRT7-regulated osteoblastogenesis pathway' will be a new therapeutic drug target to treat decreased osteogenesis and osteoporosis.

Background

Osteoporosis is a disease that causes bones to fracture easily due to a reduction in both bone mass and quality. Aging is one of its leading causes, and it is estimated that around 200 million people are affected worldwide. Fractures of the femoral neck -- the connection between the femur and the hip joint -- or of vertebrae can leave a person bedridden which increases the need for care, reduces quality of life and systemic function, and increases mortality.

Bone is a living tissue that is repeatedly broken down (bone resorption) and remade (bone formation) little by little every day. If this balance collapses and bone resorption exceeds bone formation, bone density decreases and can lead to osteoporosis. Several medications are available to treat this disease, but the number of drugs that promote bone formation are far fewer compared to those that suppress bone resorption. The development of therapeutic agents that regenerate bones is highly desired.

Sirtuins are enzymes that play important roles in controlling aging, stress responses, various areas of the metabolism, and several other body functions. In mammals, there are seven types of sirtuins, SIRT1 to SIRT7. Although SIRT7 has been reported to be involved in cancer and lipid metabolism, its role in bone tissue and bone aging was unknown.

Research

Recent experiments performed by a research group led by scientists from Kumamoto University, Japan showed that mice lacking the SIRT7 gene had reduced bone mass. A bone morphometry analysis showed that bone formation and the number of osteoblasts (bone-building cells) had been reduced. Furthermore, the researchers obtained similar results using osteoblast-specific SIRT7 deficient mice, thereby showing that (osteoblast-specific) SIRT7 is important for bone formation.

Reduced bone formation is common in people with osteoporosis, and the mechanism for this reduction is not well known. To clarify the mechanism, the researchers compared sirtuin (SIRT1, 6, and 7) expression in the skeletal tissue of young and old mice, and found that SIRT7 decreased with age. They then considered that this decrease in SIRT7 in the older specimens may be associated with decreased osteogenesis, and may even be a cause of osteoporosis.

When the researchers cultured osteoblasts (in vitro) with decreased SIRT7 expression in their next experiment, the formation of a bone-like mass (calcified nodule) was markedly suppressed compared to cultures of normal osteoblasts. Additionally, the expression of genes indicating osteoblast differentiation was also decreased, thereby revealing that SIRT7 controls the differentiation of osteoblasts.

To clarify the mechanism by which osteoblastic SIRT7 positively regulates the differentiation of osteoblasts, researchers investigated the transcription activity of the gene expression regulatory factor essential for osteoblast differentiation. They found that the transcription activity of SP7 (also known as Osterix), a protein known to induce differentiation of pre-osteoblasts into mature osteoblasts and osteocytes, was markedly decreased in osteoblasts that lacked the SIRT7 gene.

They also realized that to get high transcription activation of SP7/Osterix, it is important for SIRT7 to deacylate the 368th lysine residue of the SP7/Osterix protein. In other words, SIRT7 enhances the transcriptional activity of SP7/Osterix by chemically modifying it (deacylating the 368th lysine residue). Furthermore, the researchers were able to recover osteoblast functionality in the calcified nodule formation by introducing a mutant SP7/Osterix, which deacylated the 368th lysine of SP7/Osterix, into the osteoblasts that had reduced SIRT7 expression.

The research group is confident that their results show a new mechanism for SIRT7 as a deacylating enzyme important for transcriptional activation of the gene expression regulator SP7/Osterix and is essential for osteoblast differentiation.

"In situations where SIRT7 does not work sufficiently, such as in an older individual, osteoblast formation is impaired due to low SP7/Osterix transcriptional activity. We believe that this decreased osteogenesis is associated with osteoporosis," said study leader Dr. Tatsuya Yoshizawa of Kumamoto University. "Our results, show that the regulatory pathway of SIRT7 -- SP7 / Osterix is a promising target for new therapeutic agents to treat decreased osteogenesis and osteoporosis."

This research was published online in *Nature Communications* on 19 July 2018.

* Note: The results of this research are based on collaborative research between Kumamoto University, Tsurumi University, Tokyo Medical and Dental University (Japan), and the Max Planck Institute (Germany).

Simulations reveal role of calcium in titanium implant acceptance -- ScienceDaily

Titanium-based materials are widely used in medical implant technology. Coating the surface of titanium materials with biologically active molecules has recently shown promise to improve how cells adhere to implants and promote tissue regeneration. The mechanisms behind how peptides stick to titanium, however, are not fully understood.

Researchers at Deakin University in Australia found how calcium ions present at the interface between titanium oxide and tissues affect how well peptides bind to the metal. The team reports their findings in a special issue of *Biointerphases*, from AIP Publishing, that is highlighting women in the field of biointerface science. Using recently developed tools in molecular dynamics simulations, the group's findings provide an early understanding in how one day we might use salt's composition to finely tune the reactions between titanium implants and the body.

"This work contributes to a long-running and ongoing effort to identify systematic improvements for load-bearing implant materials," said Tiffany Walsh, an author on the paper. "The binding behaviors we have identified for these peptides in the presence of ions might guide others in the design of new implant coatings."

It is believed that coating titanium surfaces with biomolecules to adhere to host tissues is aided by nearby inorganic ions in the body. Because of their higher positive charge and role in cell signaling, calcium ions are suspected to be particularly helpful.

To tackle these questions, Walsh and her colleagues created a computer model of the oxidized surface of titanium. The group simulated two titanium-binding peptides, Ti-1 and Ti-2, in solutions of calcium chloride and sodium chloride using molecular dynamics simulations. This computation approach approximates and models the interactions between the numerous molecules in

a system. In their model, they relied on an advanced technique called replica exchange with solute tempering that accelerates the exploration of the peptide structures.

The group discovered that positively charged calcium ions helped Ti-1 adhere to the titanium surface by acting as a connector between the negatively charged titanium oxide and asparagine, a residue within the Ti-1 peptide. This process then leads to other residues pinning directly to the titanium oxide surface. For Ti-2, however, calcium ions were found to limit access to the surface.

The data from their simulations point to improved principles for designing peptides with tunable affinity to titanium application. Walsh said she expects that their findings will lead to exploring the titanium-tissue interface further, including molecules with one binding domain for titanium and one for biomolecules.

"Titanium is a common implant material, and our comprehension of how to beneficially modulate the interaction between titanium and living tissue, while very advanced, still has a lot to go," Walsh said. "We want to contribute to this ongoing effort."

Story Source:

Materials provided by **American Institute of Physics**. *Note: Content may be edited for style and length.*

Key differences between the exercise-trained heart and failing heart: This could lead to new predictors and treatments for irregular heartbeat and heart failure -- ScienceDaily

Regular exercise protects patients from heart disease whereas conditions such as high blood pressure can lead to heart failure and Atrial Fibrillation, the most common type of irregular heartbeat.

A study by scientists from Australia's Baker Heart and Diabetes Institute has examined what is happening to the lipids in the heart and circulating blood plasma during exercise compared to a failing heart as a novel way to advance prediction and treatment of heart failure.

This first-of-its-kind study has identified novel lipids in the heart and plasma in a model of exercise compared to heart disease, and found that some of these lipids have potential as new targets for predicting and treating heart failure and Atrial Fibrillation.

With increasing rates of type 2 diabetes and obesity, new prevention, diagnostic and treatment options are critical for heart failure and Atrial Fibrillation.

Heart failure is one of the most costly diseases and is responsible for among the highest rates of hospitalisation. While Atrial fibrillation, which makes the blood flow inside the heart irregular, places an individual at five times the risk of stroke and can be difficult to identify.

The study, published today in *Cell Reports*, examined nearly 600 lipids in the heart and plasma of exercise-trained mice in comparison to mice with a failing heart.

Led by researcher, Dr Yow Keat Tham, and senior authors, Associate Professor Julie McMullen and Professor Peter Meikle, they say what is particularly exciting is the discovery of a number of novel lipids with unknown roles in the heart which may represent new biomarkers and/or drug targets for Atrial Fibrillation and heart failure.

"Whilst many studies have described functional, structural and genetic differences of the exercise- trained heart and diseased heart in the quest to advance prevention and treatment, a mechanism largely unexplored is the regulation of lipids," says Dr Tham.

"Recent advancements in technology however, have allowed for this large-scale profiling work which has opened up an unexplored pathway for the identification of novel biomarkers and drug targets for the failing heart," he says.

"That's why we are excited about this large-scale lipid study which could herald new ways to predict and prevent potentially deadly conditions like heart failure and Atrial Fibrillation."

Story Source:

Materials provided by **Baker Heart and Diabetes Institute**. *Note: Content may be edited for style and length.*

New clues found to understanding relapse in breast cancer: Tumor mutations found in patients point to progressive disease -- ScienceDaily

A large genomic analysis has linked certain DNA mutations to a high risk of relapse in estrogen receptor positive breast cancer, while other mutations were associated with better outcomes, according to researchers from Washington University School of Medicine in St. Louis, the Baylor College of Medicine and the University of British Columbia.

The knowledge could help predict which patients are most likely to have their cancer return and spread, and could help guide treatment decisions. It also opens the door to developing more aggressive treatments for patients with the newly identified high-risk mutations.

The study appears Sept. 4 in the journal *Nature Communications*.

The researchers analyzed tumor samples from more than 2,500 patients with estrogen receptor positive breast cancer, one of the most common forms of the disease. These cancer cells have receptors that bind to the hormone estrogen in the nucleus of the cell and drive tumor growth.

More than 266,000 women in the United States are diagnosed with invasive breast cancer each year, according to the American Cancer Society, and about 70 percent of cases are estrogen receptor positive.

ER positive breast cancer patients have a number of treatment options that block the estrogen receptor to stop tumor growth. Such hormonal therapies are effective and less toxic than traditional chemotherapy and radiation. But some tumors develop resistance to these treatments, mutating in ways that fuel growth independent of the presence of estrogen. These types of mutations are of great interest because they are responsible for the majority of

deaths due to breast cancer.

"We would like to help doctors identify patients who are likely to do well versus those who are likely to have a recurrence," said first author Obi L. Griffith, PhD, an assistant professor of medicine and an assistant director of The McDonnell Genome Institute at Washington University School of Medicine. "Those with mutations that are associated with a good prognosis may need less intensive therapy than they might otherwise receive. But if a patient's tumor has mutations linked to high risk of relapse, it's useful to know that early so they can be treated with more aggressive therapies or even potential investigational therapies that could be targeted to their specific mutations."

The new study confirmed past work showing that relatively common mutations in genes called MAP3K1 and TP53 had opposite effects on tumor aggressiveness. Patients with MAP3K1 mutations did well, while those with TP53 mutations were likely to have a recurrence. The study also identified three genes -- DDR1, PIK3R1 and NF1 -- with relatively uncommon mutations that were associated with cancer recurrence and spreading.

"Although mutations in DDR1 and NF1 are considered rare, they are associated with early relapse, which makes them much more common in patients who unfortunately die from the disease and, thus, could be critical therapeutic targets," said Matthew J. Ellis, MB, BChir, PhD, of the Baylor College of Medicine. "Their identification also gives us very important molecular clues into the nature of aggressive tumor behavior."

"It is likely that these genes will now be included in gene panel tests, particularly when clinical trials are developed that target these mutations," Ellis added.

One unique element of this study was the age of the samples. Many were over 20 years old, allowing the researchers to know the full history of how the patients fared. But unlike more recent cancer sequencing studies, neither healthy tissue nor blood samples from those patients were collected or stored alongside the tumor. That means the old tumor samples couldn't be compared with normal DNA from the same patients. Comparing the DNA of healthy tissue versus tumor tissue in the same patient can help identify mutations

driving the cancer.

According to co-first author Nicholas C. Spies, a graduate student in Griffith's lab, scientists now have enough healthy genomes sequenced to be able to compare, on a broad population level, normal genomes to cancer genomes and use big data bioinformatics methods to pull out the mutations likely to be driving cancer, even in old samples that can't be directly compared with healthy DNA from the same patient.

The researchers also pointed out the importance of continuing to sequence cancer genomes.

"With all the breast cancer sequencing that's been done, it's tempting to think we've found everything of importance," Griffith said. "But this study tells us there is still more to discover."

This work was supported by a Susan G. Komen Promise grant, number PG12220321; a Cancer Prevention and Research Institute of Texas (CPRIT) Recruitment of Established Investigators award, grant number RR140033; the McNair Medical Institute; Susan G. Komen; the Department of Defense (DOD) Breast Cancer Research Program (BCRP) award, number W81XWH-16-0538; a Komen CCR award, number CCR16380599; the Canadian Cancer Society Research Institute to the NCIC Clinical Trials Group, grant numbers 021039 and 015469; and by the National Cancer Institute, grant numbers NIH NCI K22CA188163 and NIH NCI U01CA209936.

New mechanism for how ALS disease evolves -- ScienceDaily

A mechanism for how the disease amyotrophic lateral sclerosis, or ALS, evolves has been discovered at Umeå University, Sweden. The discovery concerns how proteins with a defect structure spread the deformation to other proteins, according to results in a new thesis. The discovery can open up for novel pharmaceutical developments in the future.

"We've been able to identify two different types of protein aggregates with different structures and propagation abilities. One type gave rise to a more aggressive disease progression, which shows that these aggregates are the driving force in the development of ALS," says Johan Bergh, doctoral student at the Department of Medical Biosciences at Umeå University, Sweden.

Together with the ALS group at Umeå University, Johan Bergh has developed a method of investigating protein aggregates formed in ALS. With this new method, it has then been possible to identify the particular protein aggregates that are driving in the emergence of ALS.

The protein that has been targeted is superoxid dismutas-1, SOD1. It has long been known that mutations in that protein can cause ALS. The goal of the research team was to investigate the way in which the protein contributes to the disease.

In several diseases afflicting the nervous system, such as in Alzheimer's and Parkinson's Disease, new studies show that some proteins assume an abberant structure. Misfolded proteins aggregate and provoke other proteins of the same kind to assume the same structure. In this way, the disease spreads step by step into the nervous system.

"Using the new method, we have shown and confirmed through animal models that the development of ALS follows the same principle as for other severe nervous disorders. Protein aggregates function as a template that

healthy proteins stick to and cause the disease to spread," says Johan Bergh.

In animal models, agregates of the SOD1 protein from animals, as well as humans, have been shown to induce ALS disease. Amyotrophic lateral sclerosis, ALS, is a fatal neurodegenerative disease which afflicts approximately 250 people annually in Sweden. Although the disease has been known for over 100 years, there is still only one medicine with a disease delaying effect available in Sweden.

"Through our new method, I hope that in the future, drugs will be developed specifically aimed at attacking these protein aggregates. Hopefully, research teams focusing on similar diseases will adopt the method. However, we are in an early phase, and developing drugs is a long-term process," says Johan Bergh.

Johan Bergh has a degree in biomedicine and is a medical doctor at Umeå University. He is now completing his doctoral studies at the Department of Medical Biosciences, started in 2010.

Story Source:

Materials provided by **Umea University**. *Note: Content may be edited for style and length.*

Increased chances of successful IVF with 18-20 eggs -- ScienceDaily

The likelihood of childbirth after in vitro fertilization (IVF) treatment increases if 18 to 20 eggs are stimulated to mature in a woman's ovaries, a dissertation at Sahlgrenska Academy, Sweden, shows. That is more eggs than the number aimed at in today's IVF treatments.

"The results can serve as the basis for how hormone stimulation before IVF treatment is designed in the future with the intention of achieving a good balance between effective and medically safe treatment," says Asa Magnusson, MD/PhD at Sahlgrenska University Hospital and Sahlgrenska Academy.

To an increasing extent both in Sweden and internationally, only one fertilized egg, or embryo, is retrieved per treatment occasion. If the treatment results in more high-quality embryos, these can be frozen and used in later attempts.

Previous research on the total number of eggs that should be retrieved have indicated that the chance of birth after IVF is optimal after about 10 eggs. It has been believed that a greater number of eggs leads not to a better chance of birth but rather to an increased risk of serious side effects.

However, the studies carried out have mainly examined the delivery rate after the first implantation, called the fresh IVF cycle, which takes place just days after the egg retrieval. Later implants of thawed embryos have not been included.

"It's more relevant to study the cumulative chance of children per IVF attempt when all embryo transfers that are generated from an egg retrieval are included," Asa says. "However, it's also important to study the risks in relation to the number of retrieved eggs and serious side effects, both during the stimulation and also neonatal pregnancy and childbirth complications."

The study does not show any connection between egg retrieval and complications for the children. On the other hand, there is a weak but statistically valid correlation between the number of retrieved eggs and placenta previa, a condition that can cause bleeding during pregnancy or childbirth.

The transfer of thawed embryos accounts for about one-third of all IVF cycles in Sweden, and the chance of birth is now comparable with the transfer of fresh embryos. It can thus be beneficial to design hormone stimulation before egg retrieval so that extra embryos can be produced and frozen to avoid additional hormone treatment.

To study the relationship between the number of collected eggs, cumulative delivery rate and serious complications associated with the stimulation, such as ovarian hyperstimulation syndrome and blood clots, treatment data from the Swedish National Quality Registry of Assisted Reproduction (Q-IVF) has been matched with data from the Swedish Patient Register and the Swedish Medical Birth Register for the 2002-2015 period.

"Previously about 10 eggs has been considered optimal for the chance of childbirth after the fresh cycle. We observed that the cumulative chance rose with an increased number of eggs, up to 18-20, and then leveled off. At the same time, the risk of complications remained at a reasonable level up to 18-20 eggs. At a higher number of eggs, the risks increased," Asa Magnusson says.

Title: Ovarian stimulation for IVF- a balance between efficacy and safety; http://hdl.handle.net/2077/55398

Story Source:

Materials provided by **University of Gothenburg**. *Note: Content may be edited for style and length.*

Body temperature regulation: How fever comes -- ScienceDaily

The appearance of fever is associated with the release in the hypothalamus of a lipid compound called prostaglandin E2 (PGE2), which has an important role in the regulation of body temperature. However, how PGE2 is supplied to or maintain in the brain, and the role of membrane transporters (in particular of the prostaglandin transporter OATP2A1, encoded by the gene SLCO2A1) in this process still needs to be elucidated.

To shed light on this question, Takeo Nakanishi at Kanazawa University, Japan, and colleagues performed a microdialysis study on mice, published in the *Journal of Neuroscience*. The researchers used mice with normal Slco2a1, with total Slco2a1 deficiency or with monocyte-/macrophage-specific Slco2a1 deficiency. They first injected the mice with physiological saline, observing the same body temperature for mice with and without SLCO2A1, indicating that the presence of OATP2A1 does not affect the basal body temperature. They then administered to the mice a pyrogen, lipopolysaccharide, that normally causes a fever. Indeed, mice with Slco2a1 developed a fever after 2h, whereas the pyrogenic effect of lipopolysaccharide was not observed in mice with total SLCO2A1 deficiency. They further demonstrate the body temperature of mice with monocyte-/macrophage-specific Slco2a1 deficiency was partially attenuated. Intriguingly, an inhibitor of OATP2A1 injected to the brain of rats with normal Slco2a1 inhibited the febrile response -- in this case only an initial rise in body temperature was observed.

The study reveals that the onset of fever is associated with increased PGE2 concentration in the hypothalamus interstitial fluid, but not in the cerebrospinal fluid, thus OATP2A1 seems to work by maintaining high levels of PGE2 in the hypothalamus, either by stimulating its secretion from glial cells in the hypothalamus and from brain capillary endothelial cells or by facilitating its transport through the blood-brain barrier. OATP2A1 seems to be involved in the secretion of PGE2 from macrophages, but OATP2A1 in

cells other than macrophages may also contribute to the febrile response.

This newly gained insight of the mechanisms underlying the inflammatory response in the brain associated with fever might be used to develop new strategies for treatment, pointing to OATP2A1 as a useful therapeutic target.

Story Source:

Materials provided by **Kanazawa University**. *Note: Content may be edited for style and length.*

Like a zipper -- how cells form new blood vessels -- ScienceDaily

Blood vessel formation relies on the ability of vascular cells to move while remaining firmly connected to each other. This enables the vessels to grow and sprout without leaking any blood. In *Nature Communications*, scientists from the Biozentrum at the University of Basel describe how this works. In this process, the cytoskeleton pushes the cell forward, while an adhesion protein subsequently closes the gap to the neighboring cell, like a zipper.

The blood vessels form a widely ramified supply system that passes through our body from head to toe. They serve as pathways for blood cells and transport oxygen as well as nutrients into each individual organ. In the embryo, blood vessels develop simultaneously in many different places, then connect with each other and thus form a complex network. The starting point of vascular growth are the so-called endothelial cells. These can migrate in groups out from a vessel and form new tubes, the capillaries.

Prof. Markus Affolter's team at the Biozentrum of the University of Basel uses the zebrafish as a model organism to investigate the development of blood vessels. In their current study, the scientists have shown that endothelial cells can migrate within vessel sprouts while remaining firmly attached to each other. If the cells were unable to remain attached, bleeding into the surrounding tissue would occur during vascularization.

Vascularization: constant rearrangement of endothelial cells

The transparency of the zebrafish embryo allows researchers to observe blood vessel formation live in the living organism. High-resolution time-lapse imaging of vascularization shows that the endothelial cells move over each other to form a capillary, thereby continuously rearranging their position in the newly forming vessel. Dr. Heinz-Georg Belting, head of the study, took a closer look at this process.

Migration and connection of vascular cells

During the rearrangement of the endothelial cells in the vessel, it is important that the cells elongate and migrate while constantly maintaining cell-cell junctions. The adhesion protein VE-cadherin and the cell skeleton play a crucial role in this process. "These two players must work closely together during these active cell movements," says Belting. "The cytoskeleton takes the first step; it ensures the elongation of the cell. VE-cadherin then anchors the cell protrusions to the neighboring cell. An additional protein finally stabilizes the newly formed endothelial cell junction. This repetitive process enables the cell to slowly creep forward." This mechanism works like a zipper, as soon as the cell has moved a little, the gap to the adjacent endothelial cell is closed.

Plasticity ensures growth and flexibility

The fact that the endothelial cells are very motile during blood vessel formation and yet always stay firmly connected ensures the plasticity of the vessel while maintaining its stability. "The ability of endothelial cells to recognize each other, to migrate and to form cell junctions prevents damage during growth. Furthermore, the blood vessels are flexible to respond to different conditions, such as fluctuations in blood pressure," says Belting "This plasticity also plays a role in wound healing, inflammation and immune response."

Story Source:

Materials provided by **University of Basel**. *Note: Content may be edited for style and length.*

Anti-inflammatory use during surgery could improve cancer outcomes -- ScienceDaily

The world's first clinical trial (SURGUVANT) evaluating anti-inflammatory use at the time of surgery in colon cancer patients to improve their cancer outcome has been published in scientific journal, *BMC Cancer*.

The research successfully tested an anti-inflammatory agent with anti-cancer properties known as 'Taurolidine' in the SURGUVANT trial which was funded by a grant from Geistlich Pharma AG, Wolhusen, Switzerland. The research was undertaken by researchers at RCSI in Dublin in collaboration with the Cork University Hospital group, University College Cork, Mercy University Hospital and the Bon Secours Hospital, Cork led by Professor Paul Redmond, RCSI Council member and Chair of Surgery at Cork University Hospital and Mr Peter O'Leary, CUH Department of Surgery.

The Surguvant trial examined a link between surgical inflammation and the recurrence of cancer. The trial randomised patients undergoing surgery for colon cancer to either a placebo or 2% Taurolidine solution. The trial reported that important components of the inflammatory response to surgery that have been shown to propagate tumour cell growth, can be attenuated successfully without compromising patient safety.

"We are delighted that this important clinical trial could be performed in Ireland. The Surguvant trial is the first of its kind to be performed worldwide showing that it is safe to use Taurolidine in this critical period of time for cancer patients where they are exposed to an inflammatory response necessary for wound healing but which can be potentially detrimental to their cancer outcome," said Professor Redmond. "Now that we have proven the safety of this treatment strategy, it remains to be demonstrated if targeting the inflammatory response to surgery will lead to improved outcomes for cancer patients. We hope to do this in much larger future trials."

Story Source:

Materials provided by **Royal College of Surgeons in Ireland**. *Note: Content may be edited for style and length.*

Induced changes to political attitude can last over time -- ScienceDaily

Cognitive scientists at Lund University and Karolinska Institutet in Sweden have demonstrated that experimentally induced changes in political attitudes can last over time. Notably, participants' who verbally motivated these "false attitudes" exhibited the largest changes. This is the first time a lasting effect of the choice blindness phenomenon has been observed.

In the study, a total of 372 participants completed a survey on healthcare, education, and environmental policy issues. Afterwards, half of them were asked to simply verify their answers, whereas the other half was asked to also give underlying arguments for their views. However, they were unaware that some of their answers had been manipulated by the experimenters and shifted to the opposite side of the spectrum. Only about 50 % of these manipulated answers were corrected by the participants, and the rest were accepted as being their own.

"This is in line with previous results using choice blindness to influence ideological attitudes," says Petter Johansson, one of the researchers behind the study. "But a critical question of interest to us was whether this attitude shift would persist, despite us not giving any further arguments or encouragement for the new position."

To investigate this, at the end of the experiment the participants were asked to complete a second survey with new questions, which also included the questions that were previously manipulated. They then returned after one full week to complete a follow up, again including the manipulated questions.

The results showed that when participants initially accepted the manipulated responses as their own, their attitudes later on shifted significantly in the direction of the manipulation. However, responses to questions that had not been manipulated kept the same position throughout all the questionnaires.

"This is of particular interest given that it's the first time lasting attitude change from choice blindness has been shown. Importantly, it shows how false beliefs, and feedback about those beliefs, can powerfully shape the interpretation and memories about one's political opinions." Philip Pärnamets, researcher at Karolinska Institutet, points out.

"It seems that part of what it might mean to hold a political attitude is to be able to draw on memories of having stated that attitude. In a sense, me being against tax cuts might result from me remembering having expressed that attitude previously. Using our manipulation, we are able to alter the participants beliefs about themselves, and we find that this leads them to change their attitudes," he explains.

When comparing those participants that only verified their answers with those who also gave supporting arguments, the researchers found that both groups exhibited lasting opinion changes, but that the effect was much larger for the participants who provided arguments.

"When people argue for a manipulated answer, we know that regardless of what they say, it cannot possibly be the reason for their original choice. This type of confabulation has hardly been studied outside the clinical context, but perhaps it is something we constantly do in our ordinary lives," main author Thomas Strandberg says.

"We also found that people who started to argue for a manipulated answer, but then suddenly stopped to correct it, still modified their opinions somewhat. These smaller shifts need to be further investigated, but it suggests that even seemingly innocuous amounts of confabulation can impact our attitudes," he continues.

"On a more positive note, in the current political climate of increasing polarization and ideological hostility, our study shows that people truly have the potential to be flexible in their political views. All that is needed is a way, like choice blindness does, to invite people to reason openly, and unleash their own powers of argumentation," Thomas Strandberg concludes.

Footnote: The study was entirely anonymous. After the experiment, the researchers explained to the participants exactly how and why their answers

had been swapped, and they gave their consent to be included in the study.

Concussions loosen insulation around brain cells: Condition detected two weeks after concussion, when players said they felt ok -- ScienceDaily

Detailed scans of concussed university hockey players found that the protective fatty tissue surrounding brain cell fibers was loosened two weeks after the injury -- even though the athletes felt fine and were deemed ready to return to the ice.

A loosening of that insulation, called myelin, slows the transmission of electrical signals between brain cells, or neurons. Researchers have previously shown in animals that this loosened myelin can completely deteriorate with subsequent blows -- a condition that resembles the neurodegenerative disease multiple sclerosis.

"This is the first solid evidence in humans that concussions loosen myelin," said Alex Rauscher, an Associate Professor in the Department of Pediatrics and the Canada Research Chair in Developmental Neuroimaging at the University of British Columbia. "And it was detected two weeks after the concussion, when the players said they felt fine and were deemed ready to play through standard return-to-play evaluations. So athletes may be returning to play sooner than they should."

Published this month in *Frontiers in Neurology*, this is the third study arising from the unusual before-and-after study of UBC hockey players. The 45 athletes had their brains scanned with magnetic resonance imaging (MRI) before the season began; if they were concussed, they were re-scanned three days afterwards, two weeks afterwards, and two months afterwards. Eleven athletes were concussed during the season, and most of them underwent the additional MRI scans.

Conventional MRI imaging -- the kind done in hospitals to assess brain injury -- does not reveal myelin loosening. Rauscher and postdoctoral research fellow Alex Weber used advanced digital analysis of the scans, using a UBC-developed, pixel-based statistical analysis to find changes that visual inspection could not reveal.

Previous analysis of the concussed athletes' scans, published by Rauscher in 2016, had shown changes to the myelin in the corpus callosum -- the part of the brain that helps the brain's two hemispheres communicate, and is most susceptible to damage from sudden collisions against the interior of the skull. But the researchers didn't know whether the myelin was diminished, akin to multiple sclerosis, or altered in some other way.

The good news is that it was something else -- a temporary loosening around the nerve fibers that connect brain cells. When the concussed players were re-scanned two months after their concussions, their myelin had returned to normal.

But Weber says the findings provide a convincing reason to keep concussed athletes on the bench even if they no longer exhibit any symptoms, as measured by a standard test of cognitive abilities, balance, coordination and mood.

"These results show that there is some damage happening below the surface at least two weeks after a concussion," Weber says. "Passing a concussion test may not be a reliable indicator of whether their brain has truly healed. We might need to build in more waiting time to prevent any long-term damage."

Story Source:

Materials provided by **University of British Columbia**. *Note: Content may be edited for style and length.*

Internet and telephone assisted training for child disruptive behavior found to be effective -- ScienceDaily

Positive long-term outcomes, such as a reduction in child disruptive behavior and increased parental skills, have been reported in a new study in the *Journal of the American Academy of Child and Adolescent Psychiatry* (JAACAP). For a large number of families, screened from the general population, internet- and telephone-assisted trainings that target disruptive behavior in children at age 4 decreases the likelihood of such disruptive behavior occurring. The program was effective 24 months after initiation.

Preschool children with disruptive behavior show significant functional impairment at home, daycare, school and in community settings. A number of studies have shown that this type of behavior has untoward, long-term, harmful consequences, including mental and physical health problems, crime, substance abuse, and increased risk of suicidality later in life. Untreated disruptive behavior disorders are some of the most costly early childhood psychiatric disorders. Parent training is one of the most effective approaches for the psychosocial treatment of disruptive behavioral problems in young children. However, no previous Randomized Controlled Trial (RCT) has been conducted on an intervention offering remote or internet-assisted parental training and population-based screening. This study reports on two-year outcomes from preschool children with disruptive behavioral problems who were randomized to receive either an 11-week internet-assisted parental training or an educational control condition. The study is unique, in part, due to its use of a population-based screening to facilitate enrollment and due to its long-term follow-up period with an assessment at 24 months which had a very low attrition rate.

Altogether, 730 of the 4,656 four-year-old children who attended annual child health clinic check-ups in Southwest Finland met the criteria for high level disruptive behavioral problems. 464 parents participated in the 11-week

Strongest Families Smart Website (SFSW) intervention program, or an educational control (EC) group. When the SFSW and EC groups were compared between baseline and after the 24-month follow-up, the primary outcome of the Child Behavior Check List (CBCL) externalizing score showed significantly higher improvements in the SFSW group (effect size 0.22; $p<0.001$). In addition, most of the child psychopathology measures, including aggression, sleep problems, anxiety, and other emotional problems decreased significantly more in the SFSW group than in the EC group. Similarly, parental skills increased more in the SFSW group than in the EC group.

Interestingly, children in the SFSW group made significantly less use of child mental health services than the EC group during the 24-month follow-up period (17.5 percent vs. 28.0 percent).

"Our findings address some key public health challenges in delivering parent training programs," said lead author Andre Sourander, MD, PhD, of the University of Turku, Finland, and leader of the research group.

"When traditional parental training requires referral to clinical services, it often results in substantial delays, and older children are more likely to require adjunctive treatment to parental training. Studies have identified that internet-assisted treatment programs may offer certain benefits over traditional interventions: these include high levels of support; greater accessibility; convenience; and reduced costs. Studying feasibility and effectiveness of digitalized child mental health interventions is important because of the global shortage of skilled staff who can address child mental health problems."

According to Dr. Sourander, the parents were highly motivated and continued their involvement in the training program. Most importantly, the treatment effects were maintained until two years. Identifying children at risk in the community at an early stage enabled local government services to provide an effective parent training program for a large number of families, including many who would not have participated in clinic-based services.

Story Source:

Mouse models may not accurately mimic severity of gonorrhea infection -- ScienceDaily

There is an urgent need to develop a vaccine to prevent gonorrhea infection due to rapidly increasing incidence and growing antibiotic resistance. BUSM researchers (in collaboration with University of Toronto researchers) have been investigating the use of animal models of gonorrhea, to study how the infection evolves and for potential use to determine the efficacy of next generation vaccines. They found that the mouse model may not fully reflect the severity of the infection and the types of immune responses seen in humans.

Gonorrhea is a rapidly worsening public health threat. In 2017 more than 550,000 new cases of gonorrhea were reported to the Centers for Disease Control and Prevention (a 67 percent increase from 2013), while the World Health Organization places global yearly incidence at 106.1 million cases. Researchers believe these figures may underestimate the actual disease burden by up to two-thirds. In addition, there is significant evidence that gonorrhea is becoming increasingly drug-resistant. According to most experts in the field, these factors make it even more essential that we develop effective gonorrhea vaccines and have adequate animal models in which to test their efficacy.

""The use of models in infectious diseases to examine pathogenesis and potential vaccine development is fraught with difficulties as many of these human specific pathogens have evolved mechanisms of infection and immune evasion specific for humans. It is essential that when models are used, the details of their infections are fully examined to ensure they at least somewhat mimic what occurs in humans," said Lee M. Wetzler, MD, Professor of Medicine and Microbiology.

Story Source:

Materials provided by **Boston University School of Medicine**. *Note: Content may be edited for style and length.*

Improving operations for the brain's most malignant tumor -- ScienceDaily

Important research by Barrow Neurological Institute neurosurgeons and University of Washington (UW) scientists on novel imaging technology for malignant brain tumors was published in the August issue of the Nature journal, *Scientific Reports*. The research was conducted by Drs. Mark Preul and Evgenii Belykh at the Barrow Neurological Institute Neurosurgery Research Laboratory along with Drs. Leonard Nelson and Eric Seibel from the Department of Mechanical Engineering and the Human Photonics Laboratory at the University of Washington.

The neurosurgeons and scientists evaluated use of state-of-the-art optical technology built into commercial grade operating microscopes used in neurosurgery to detect the glow produced by adding the pro-drug 5-ALA to experimental malignant brain tumors. 5-ALA is approved for administration to patients to increase the detection of the margin of invading brain glioma tumors, and thereby allow for a wider or more extensive brain tumor removal. As the most important visualization tool in daily use for neurosurgery, operating microscopes are gaining advanced functionality with innovative illumination modes.

To ensure surgical success, the neurosurgeon must fully understand the illumination properties and functionality of the microscope, especially within the context of fluorescence-guided tumor resection. The principle of fluorescence-guided tumor resection relies on the use of targeting agents with fluorescent properties that can be administered to patients before or during surgery. These agents are intended to accumulate within and around the tumor tissue or within the cells of the tumor, depending on the selectivity and actions of the fluorophore. The desired diagnostic result is to improve visual differentiation and detection of the tumor tissue margins during surgery based on fluorescence. The most notable recent example of a fluorescent agent developed for tumor detection in neurosurgery is 5-aminolevulinic acid (5-ALA), which is used to indicate the presence of tumors and the border

regions of malignant gliomas.

Understanding both the nuances of its fluorescent properties and the effects that occur with changes in excitation intensity and duration of light exposure is critical to optimizing the intraoperative utility of 5-ALA as a guide for the surgeon to discriminate the border region of the tumor. The process of drug signal photobleaching and the reduction of fluorescence that occurs are believed to be directly related to the light intensity of the operating microscope and the duration of exposure.

However, although in wide use, this state-of-the-art imaging has not been thoroughly evaluated for commercial grade operating microscopes used for neurosurgery. The scientific group evaluated for the first time the rate at which the fluorescence signal intensity caused by 5-ALA declines with exposure to light. The scientists found wide variability in the microscopes in neurosurgery for detecting the fluorescence signal and that it bleaches out at variable rate detection. Commercial grade operating microscopes are increasingly outfitted with modules for fluorescence emission detection at various wavelengths. These special illumination modules have become commonplace during neurosurgery for cerebrovascular disorders and are increasingly used for brain tumor resection procedures. Comprehension of the microscope illumination output, fluorescence, and photobleaching can have a profound influence on the suitable protocol a neurosurgeon will follow for tumor resection, especially at the tumor invasive margin. The extent of resection for both low-grade and high-grade gliomas has a weighty impact on patient life expectancy.

Drs. Nelson and Seibel stated: "Our development of standardized methods thus becomes increasingly important for clinical trials and studies that obtain measurements or observations using the surgical microscope in intraoperative fluorescent modalities during the resection of neoplastic brain tissue. Our study advocates for the detailed quantitative analysis of fluorescence for improved accuracy of fluorescence guidance and identification of tumor tissue."

Drs. Preul and Belykh further stated: "However, conventional operating microscopes were not originally designed for quantitative fluorescence measurement, and multiple parameters that can influence fluorescence

detection and measurement have not been well described. Our findings about the limitations of quantification of fluorescence with neurosurgical operating microscopes potentially have considerable research and clinical implications. If we're going to use what we believe to be advanced imaging technology, then we need to have confidence that what we're using for fluorescence signal quantitative detection in our clinical systems is proven, reliable, with built-in standards and can be used for patients for their benefit. This is especially true as we develop more sensitive and specific technology to detect and treat such aggressive brain tumors as affected Sen John McCain."

The research was funded by NIH R01 EB016457, PI-Seibel, Advanced biophotonics for image-guided robotic surgery, the Barrow Neurological Foundation, and the Barrow Neurological Institute Newsome Chair in Neurosurgery Research held by Dr. Preul.

Story Source:

Materials provided by **St. Joseph's Hospital and Medical Center**. *Note: Content may be edited for style and length.*

Brain scans could distinguish bipolar from depression: Looking inside the brain to distinguish bipolar from depression -- ScienceDaily

New research has found that neurons deep inside the brain could hold the key to accurately diagnosing bipolar disorder and depression.

The research team used sophisticated MRI scanning to see how the amygdala -- a set of neurons that play a key role in processing emotions -- reacts as a patient processes facial expressions such as anger, fear, sadness, disgust and happiness.

The research showed that this key structure within the brain responds differently depending on whether the person has bipolar disorder or depression.

In people with bipolar disorder, the left side of the amygdala is less active and less connected with other parts of the brain than in people with depression.

The findings from this study had 80% accuracy in making this distinction.

Lead researcher Dr Mayuresh Korgaonkar from the Westmead Institute for Medical Research and the University of Sydney said these differences could potentially be used in the future to differentiate bipolar disorder from depressive disorders.

"Mental illness, particularly bipolar disorder and depression, can be difficult to diagnose as many conditions have similar symptoms," Dr Korgaonkar said.

"These two illness are virtually identical except that in bipolar individuals also experience mania.

"This means distinguishing them can be difficult and presents a major clinical challenge as treatment varies considerably depending on the primary diagnosis.

"The wrong diagnosis can be dangerous, leading to poor social and economic outcomes for the patient as they undergo treatment for a completely different disorder.

"Identifying brain markers that could reliably tell them apart would have immense clinical benefit.

"Such a marker could help us better understand both these disorders, identify risk factors for developing these disorders, and potentially enable clear diagnosis from early onset," Dr Korgaonkar said.

Approximately 60% of patients with bipolar disorder are initially misdiagnosed as major depressive disorder.

Alarming, it can take up to a decade for these patients to be accurately diagnosed with bipolar disorder.

Bipolar disorder often first presents in the depressive phase of the illness and bipolar depression is similar to major depression in terms of clinical symptoms.

Emotion processing is a core problem underlying both these disorders.

Dr Korgaonkar and his team are now running phase 2 of this study, which aims to further characterise these identified markers in a larger cohort of patients.

Story Source:

Materials provided by **Westmead Institute for Medical Research**. *Note: Content may be edited for style and length.*

Artificial cells are tiny bacteria fighters -- ScienceDaily

"Lego block" artificial cells that can kill bacteria have been created by researchers at the University of California, Davis Department of Biomedical Engineering. The work is reported Aug. 29 in the journal *ACS Applied Materials and Interfaces*.

"We engineered artificial cells from the bottom-up -- like Lego blocks -- to destroy bacteria," said Assistant Professor Cheemeng Tan, who led the work. The cells are built from liposomes, or bubbles with a cell-like lipid membrane, and purified cellular components including proteins, DNA and metabolites.

"We demonstrated that artificial cells can sense, react and interact with bacteria, as well as function as systems that both detect and kill bacteria with little dependence on their environment," Tan said.

The team's artificial cells mimic the essential features of live cells, but are short-lived and cannot divide to reproduce themselves. The cells were designed to respond to a unique chemical signature on E. coli bacteria. They were able to detect, attack and destroy the bacteria in laboratory experiments.

Artificial cells previously only had been successful in nutrient-rich environments, Tan said. However, by optimizing the artificial cells' membranes, cytosol and genetic circuits, the team made them work in a wide variety of environments with very limited resources such as water, emphasizing their robustness in less-than-ideal or changing conditions. These improvements significantly broaden the overall potential application of artificial cells.

Antibacterial artificial cells might one day be infused into patients to tackle infections resistant to other treatments. They might also be used to deliver drugs at the specific location and time, or as biosensors.

Coauthors on the paper are Yunfeng Ding, Eliza Morris, Luis Contreras-Llano and Michelle Mao. The work was supported by NSF, a Branco-Weiss Fellowship to Tan and by a UC MEXUS-CONACYT Doctoral Fellowship to Contreras-Llano.

Story Source:

Materials provided by **University of California - Davis**. *Note: Content may be edited for style and length.*

Neuropsychiatric disorders: Dopamine study offers hope for improved treatments -- ScienceDaily

New work from researchers at Columbia University Vagelos College of Physicians and Surgeons sheds light on how dopamine receptors signal within cells, opening the door for more targeted -- and more tolerable -- therapeutics to treat an array of neuropsychiatric disorders.

The study's findings have been published in the journal *Molecular Psychiatry*.

The central nervous system's dopamine receptors play a critical role in a variety of neural processes, including motor control, learning and memory, and reward. The focus of this study, the dopamine D2 receptor (D2R), is an important target in the treatment of disorders such as schizophrenia and Parkinson's disease. Drugs used to treat these conditions either block or activate these receptors to address dysfunctional receptor signaling. Antipsychotic drugs that target D2Rs, however, can have many unpleasant side effects, including weight gain, involuntary movements, and decreased motivation.

Scientists know that D2Rs send signals through two main pathways within cells -- either by activating G proteins or by G-protein independent arrestin-signaling. Recent studies of opioid receptors -- targeted for pain relief -- suggest that it may be possible to maintain the therapeutic effects while avoiding negative side effects, such as respiratory depression, by selectively activating the G protein signaling pathway. "We asked whether these signaling pathways might also lead to different behavioral effects at the D2R, and whether this might provide a new approach to improved antipsychotic drugs with fewer side effects," says Dr. Jonathan Javitch, Lieber Professor of Experimental Therapeutics in Psychiatry and professor of pharmacology at Columbia University Vagelos College of Physicians and Surgeons.

In order to determine whether the two pathways regulate different behaviors, the researchers examined mice that were engineered to carry a mutated D2R that only facilitated the arrestin pathway. In these mice, the mutant dopamine receptor restored motor function just as the non-mutant form of the receptor does, indicating that arrestin recruitment can enhance motor function on its own. In contrast, motivation was enhanced only by wild-type D2R. "This finding was quite exciting as it indicates that the activational component of motivation that enhances locomotion is regulated by a different intracellular mechanism than the reward driven directional component," says Dr. Christoph Kellendonk, associate professor of pharmacology (in Psychiatry) at Columbia University Vagelos College of Physicians and Surgeons. "For the former, arrestin signaling is sufficient whereas the latter requires activation of G-proteins."

"These results offer the exciting possibility that therapeutic approaches targeting specific D2R-mediated signaling pathways could not only treat psychosis, but also avoid some of the adverse side effects experienced by patients taking the existing, less targeted medications," says Javitch.

Story Source:

Materials provided by **Columbia University Irving Medical Center**. *Note: Content may be edited for style and length.*

Biophysics: Self-centered -- ScienceDaily

Essential biological processes, such as cell division, must be tightly regulated. For example, correct localization of the plane of cell division is vital for correct segregation of the duplicated genomes, and hence for the survival of both daughter cells. Bacterial cells generally divide symmetrically by forming a contractile ring, which is progressively constricted to form two daughter cells of equal size. In a new study, LMU doctoral student Silke Bergeler and her supervisor Professor Erwin Frey have developed a model that explains how the plane of division is specified in the rod-shaped bacterium *Myxococcus xanthus*. The model, which is based on experimental work done by Professor Lotte Søgaard-Andersen and her group at the Max Planck Institute for Terrestrial Microbiology in Marburg, is described in the online journal *PLoS Computational Biology*.

Prior to cell division, the bacterial genome is replicated. The region occupied by the bacterial chromosome (or 'nucleoid') is functionally equivalent to the nucleus in the cells of higher organisms. When the cell divides, the nucleoid must be centered, so that the duplicated nucleoids are equally divided between the two daughter cells. Three proteins have been identified which are required for the proper localization of the plane of cleavage at mid-cell in *M. xanthus*. Experiments by the research group in Marburg have shown that two of these, named PomX and PomY, assemble to form a large cluster, which will ultimately mark the position of mid-cell. The third, PomZ, is an ATPase -- an enzyme that binds the nucleotide ATP and can convert it into ADP. Dimer molecules made of two ATP-bound PomZ proteins can attach to the chromosomal DNA and diffuse along it, and can also bind to the PomXY cluster and diffuse at a lower rate. The action of this system ensures that the cluster is localized to the midpoint of the nucleoid, which coincides with mid-cell, where the contractile ring will form.

"We have developed a mathematical model and used it to study the detailed dynamics of the process that leads to the positioning of the cluster in the center of the nucleoid," says Bergeler. The analysis revealed that the PomZ

proteins are the crucial components in this operation. They first bind to the chromosomal DNA and subsequently recruit the cluster, thus tethering it to the nucleoid. Simultaneous binding of PomZ to the cluster and the chromosomal DNA, however, eventually activates the ATPase activity of PomZ, which causes it to detach from both the cluster and the DNA. It then diffuses in the cytosol and finally binds randomly to the nucleoid again. In addition to this delay, one other factor plays an important role in shuttling the cluster to midnucleoid: The chromosome exhibits a certain degree of elasticity, such that a specific position on the chromosome can explore the region around its equilibrium position as a result of thermal fluctuations. "Thanks to this elasticity, PomZ proteins that are bound to both the chromosome and the PomXY cluster can exert a net force on the cluster." Moreover, simulations show that the velocity of the cluster depends on the difference between the fluxes of PomZ into the cluster from either side. "The crucial point is that, if the cluster is asymmetrically placed, more PomZ proteins will be fed into it from the direction of the longer segment of the nucleoid than from the opposite side," Bergeler explains. This imbalance in the flux of PomZ serves to push the cluster toward, rather than away from, mid-cell. When the cluster's location coincides with the center of the chromosome, it remains in place because the number of PomZ molecules impinging on it from each side is essentially the same.

According to its authors, the model is also of interest in the context of other intracellular positioning systems, such as the Min system used to center the contractile ring in *E. coli*, plasmid segregation, or the mechanisms that are responsible for the localization of flagella. "By studying the similarities and differences between the various systems, one can identify the general mechanisms on which they are based," says Frey. This view is supported by the finding that the proposed mechanism can in principle lead to two distinct dynamic behaviors. If the dynamics of PomZ's movement along the nucleoid is slow relative to the diffusion of the cluster, the latter does not stably maintain its position at midnucleoid. Instead, it oscillates back and forth about the center of the nucleoid.

Story Source:

Materials provided by **Ludwig-Maximilians-Universität München**. *Note:*

Content may be edited for style and length.

How weight loss is linked to future health for older adults -- ScienceDaily

Studies describing the effects of weight loss on health rarely consider age. However, weight loss during middle age likely has different effects on your health than does weight loss when you're 65-years-old or older -- especially when you're older than 85.

Although some studies have found that weight loss in older adults is generally linked to an increase in illness and death, researchers say that these studies were either too short or were based on information that may have been interpreted incorrectly.

However, one study about fractures and osteoporosis (a medical condition in which bones become thin, lose density, and become increasingly fragile) looked specifically at health and weight for women who were over age 65. Reviewing more than 20 years' worth of data for study participants, the team of researchers responsible for this study had the chance to examine links between long-term weight gain/loss and health. Their findings were published in the Journal of the American Geriatrics Society.

In their new study, the research team evaluated information from the Study of Osteoporotic Fractures. The research team theorized that women with greater weight loss, greater variability in their weight, and/or abrupt declines in weight would be less able to function physically at year 20, and would be more likely to experience poorer health outcomes one to five years after year 20. This theory was based in part on an earlier, related study by the same research team also making use of the Study of Osteoporotic Fractures. In that earlier work, the researchers discovered that the rate of weight loss over 20 years was linked to developing mild cognitive impairment or dementia in women surviving past age 80. (This was not the case for participants with sudden weight loss or changes in weight).

The current study revealed that every 22 pounds of weight loss over 20 years

was linked to a 23 percent increased risk of death and a 52 percent increased risk of hip fracture.

The team also said that women with moderate weight loss (20 or more pounds) over 20 years had a 74 percent increased risk of death. Their risk for hip fracture increased nearly three times, compared to women who had not lost weight. They were nearly four times more likely to have poor physical function after 20 years, compared to women with no weight loss.

Even women who had lost a small amount of weight (less than 20 pounds) over 20 years had an increased risk of death, but no increased risk of hip fracture or of poor physical function.

However, the researchers found no link between weight loss and chances for experiencing two or more falls during approximately 18 months of follow-up.

Weight variability and abrupt weight loss were not associated with poor health outcomes, such as falls, fractures, and death. However, those with the most weight variability over 20 years were two times more likely to have poor scores for measures of physical function.

As women age, they risk weight loss because of changes in senses of taste and smell, poorer digestion, and difficulty absorbing nutrients. In addition, other challenges such as loneliness, being in a long-term care facility, having mental health problems such as depression, and/or having limited ability to get around independently can lead to weight loss, said the researchers. "Our findings suggest that weight loss may contribute to the process of health decline," said Dr. Erin LeBlanc, lead author of the study at Kaiser Permanente's Center for Health Research, Portland, Oregon.

The researchers added: "Our results suggest long-term weight loss in older women may be a marker for increased risk of poor health outcomes. Therefore, we should pay attention to women who have survived into their 80s and 90s who have experienced moderate weight loss, regardless of whether there was an abrupt weight decline." Looking closely at women's nutrition, as well as social, environmental, and physical factors impacting well-being also could help preserve health and physical function into old age. However, additional research is needed, the researchers concluded.

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Natural 'breakdown' of chemicals predicts lung damage in 9/11 firefighters -- ScienceDaily

Abnormal levels of more than two dozen metabolites -- chemicals produced in the body as it breaks down fats, proteins and carbohydrates -- can reliably predict which Sept. 11 firefighters developed lung disease and which did not, a new analysis shows.

Researchers say the results, published by NYU School of Medicine researchers in the journal *BMJ Open Respiratory Research* online Sept. 4, could lead to metabolic tests for early detection of lung damage in all disaster victims exposed to fine particles from fire, smoke, and toxic chemicals, not just 9/11 firefighters.

The study, researchers say, offers the first evidence that metabolite blood tests conducted within months of the disaster could still help in the detection of obstructive airway disease, or OAD. Such analysis could aid in diagnosing OAD in the roughly 9,000 firefighters exposed to toxic chemicals at the World Trade Center (WTC) on Sept. 11, 2001, or during the cleanup that followed.

Senior study investigator Anna Nolan, MD, says the team hopes to develop a precise chemical profile of firefighters most at risk of developing OAD -- including asthma, chronic bronchitis, and/or emphysema -- by analyzing fluid samples from 9/11 firefighters not included in the current study.

Nolan, an associate professor in the Department of Medicine at NYU Langone Health, says her team's findings raise the possibility that correcting metabolic imbalances -- through dietary changes or food supplements -- could ward off or even reverse loss of lung function. Already, the team has plans to test a low-calorie Mediterranean diet, known for its ability to rebalance the body's metabolites, for its potential effects on the firefighters'

lung health.

"Healthy lung function is essential for everyone, but especially firefighters, to carry out their work," says Nolan. She says all firefighters, including those exposed to toxic chemicals on or after 9/11, are routinely monitored through annual physical and medical exams, and "decreases in their lungs' strength to inhale or blow out air are a sign of respiratory ill health."

Nolan says previous research has shown that nearly one in 10 firefighters exposed to dust at the WTC site is showing signs of lung injury. She says the WTC dust was laden with dangerous heavy metals, such as chromium and mercury, in addition to powdered concrete and toxic fibrous glass, asbestos, and components of jet fuel. When firefighters inhaled some of the dust at the disaster site, she says, it amounted to a slow chemical burning of their lung tissue that, in turn, led to chronic inflammation and lung injury.

For the current study, led by co-investigators George Crowley and Sophia Kwon, DO, MPH, the NYU Langone team analyzed blood levels of 580 metabolites frequently found in the body. All samples came from 9/11 firefighters who were tested within seven months of the disaster, and whose lung function has been tested annually ever since. Researchers matched 15 firefighters whose lung function had sharply declined by 2015 with 15 whose lung function had remained healthy, despite similar levels of exposure to WTC dust. Advanced computer software was then used to analyze the large volume of metabolite data.

When researchers plotted all metabolites on graphs, various chemical groups stood out as highly predictive of the majority of cases of OAD and lung injury.

Key among them were:

- decreases in sphingolipids, such as sphingosine 1-phosphate, a fat that has previously been linked to higher rates of asthma and found to trigger inflammation;
- declines in branched-chain amino acids, the building blocks of proteins, including leucine and valine, whose supplementation has in previous research been shown to counter chronic obstructive pulmonary disease

(COPD);

- increases in levels of stress hormones, especially vanillylmandelate, which may lead to elevated levels of fatty acids, potentially inducing inflammation.

Nolan says it is likely that metabolic imbalances contribute to the chronic inflammation that underlies most OAD and lung injury.

Study provides 10-year risk estimates for dementia, which may help with prevention in high-risk individuals who potentially could benefit from early targeted prevention -- ScienceDaily

A Danish study provides 10-year absolute risk estimates for dementia specific to age, sex and common variation in the APOE gene, which may help identify high-risk individuals who potentially could benefit from early targeted prevention. The study is published in *CMAJ* (Canadian Medical Association Journal).

Dementia is a major cause of disability in older adults worldwide, yet no effective treatment is currently available. Reduction of risk factors for dementia may have the potential to delay or prevent development of the disease. Age, sex and common variation in the APOE gene identify high-risk individuals with the greatest potential to benefit from targeted interventions to reduce risk factors.

The apolipoprotein E (APOE) protein is key for metabolizing cholesterol and to clear beta-amyloid protein from the brain in individuals with Alzheimer disease.

"Recently, it was estimated that one-third of dementia most likely can be prevented. According to the Lancet Commission, early intervention for hypertension, smoking, diabetes, obesity, depression and hearing loss may slow or prevent disease development. If those individuals at highest risk can be identified, a targeted prevention with risk-factor reduction can be initiated early before disease has developed, thus delaying onset of dementia or preventing it," says Ruth Frikke-Schmidt, professor at the University of Copenhagen, and at the Department of Clinical Biochemistry, Rigshospitalet, Copenhagen, Denmark.

The study looked at data on 104 537 people in Copenhagen, Denmark, and linked it to diagnoses of dementia. Researchers found that a combination of age, sex and a common variation in the APOE gene could identify high-risk groups, with a 7% risk for women and 6% risk for men in their 60s; a 16% and 12% risk, respectively, for people in their 70s; and a 24% and 19% risk, respectively, for those aged 80 years and older.

The generalizability of the study is limited as it included only people of white European background.

"The present absolute 10-year risk estimates of dementia by age, sex and common variation in the APOE gene have the potential to identify high-risk individuals for early targeted preventive interventions," the authors conclude.

Story Source:

Materials provided by **Canadian Medical Association Journal**. *Note: Content may be edited for style and length.*

Targeted and population-based strategies both necessary for blood pressure control: Shift to team-based care can improve prevention and care for hypertension -- ScienceDaily

Hypertension, or high blood pressure, is the leading risk factor for heart disease, and improvements in both targeted and population-based strategies for blood pressure control can lead to better prevention and control of hypertension, according to a review paper published today in the *Journal of the American College of Cardiology*. This paper is part of an eight-part health promotion series where each paper will focus on a different risk factor for cardiovascular disease.

The prevalence of hypertension globally is high and continues to increase. High blood pressure is associated with an increased risk of stroke, ischemic heart disease, heart failure and noncardiac vascular disease, as well as other conditions.

"Hypertension is caused by a combination of genetic, environmental and social determinants," said Robert M. Carey, MD, professor of medicine at the University of Virginia School of Medicine and lead author of the paper. "While genetic predisposition is nonmodifiable and conveys lifelong cardiovascular risk, the risk for hypertension is modifiable and largely preventable due to a strong influence by key environmental and lifestyle factors."

Modifiable lifestyle factors, which are gradually introduced in childhood and early adult life, include being overweight/obesity, unhealthy diet, high sodium and low potassium intake, insufficient physical activity and consumption of alcohol. Many adults do not change their lifestyle after being diagnosed with hypertension and sustaining any changes that are made can be

difficult.

Social determinants such as race and socioeconomic status are also risk factors for hypertension. High blood pressure is more prevalent in black and Hispanic populations as well as poorer areas and certain geographical areas such as the southeastern U.S.

According to the authors, prevention and control of hypertension can be achieved through targeted and population-based strategies. The targeted approach is the traditional strategy used in health care practice and seeks to achieve a clinically important reduction in blood pressure for individual patients. The population-based strategy aims to achieve small reductions that are applied to the entire population, resulting in a small downward shift in the entire blood pressure distribution. Studies have shown that the population-based approach may be better at preventing cardiovascular disease compared with the targeted strategy.

Factors preventing successful hypertension control include inaccurate blood pressure measurement and diagnosis of hypertension, lack of hypertension awareness and access to health care, and proper hypertension treatment and control. Low rates of medication adherence is also a common problem.

"Challenges to the prevention, detection, awareness and management of hypertension will require a multipronged approach directed not only to high-risk populations, but also to communities, schools, worksites and the food industry," Carey said.

In the review, the authors discuss the Chronic Care Model, a framework for redesigning health care and addressing deficiencies in the care of chronic conditions such as hypertension, which may offer strategies for overcoming barriers at the health system, physician, patient and community levels. It is a collaborative partnership among the patient, provider and health system that incorporates a multilevel approach for control of hypertension. The model includes six domains -- decision support, self-management support, delivery design, information systems, community resources and health care systems -- which have been shown to lead to activated patients, responsive health care teams, improved health services and treatment outcomes, and cost-effectiveness. It also recognizes a collaborative partnership between the

patient, provider and the care team. Community groups and organizations also play a significant role in providing health care information and support to various populations. Connected health, such as telemedicine and telephone and mobile health interventions can also help deliver improved care to a of greater number of patients with hypertension.

"Remarkable progress has been made in the understanding of blood pressure as a risk factor for heart disease and improving approaches to the prevention and treatment of hypertension," said Carey. "However, further research is still necessary to optimize care for these patients."

Story Source:

Materials provided by **American College of Cardiology**. *Note: Content may be edited for style and length.*

Patients with new-onset AFib after TAVR at highest risk for complications: Better care management strategies are needed to help reduce risks -- ScienceDaily

Patients developing AFib after TAVR are at higher risk of death, stroke and heart attack compared to patients who already had AFib prior to the procedure, according to a study today in *JACC: Cardiovascular Interventions*. The paper is the first nationwide examination of patients who developed AFib for the first time following TAVR.

Transcatheter aortic valve replacement (TAVR) is a minimally invasive procedure to replace aortic valves by inserting a catheter into an artery in the leg to reach the patient's heart. Heart rhythm disorders, particularly atrial fibrillation (AFib), frequently complicate TAVR. Prior research has shown that if a patient has AFib before TAVR, they are much more likely to have worse outcomes after the procedure in comparison to patients who do not have pre-existing AFib. When it comes to patients who did not have AFib before TAVR, but developed it after the procedure, data has been limited until now.

"We found that about 8 percent of patients undergoing TAVR that did not have pre-existing AFib developed new-onset AFib after their procedure," said lead study author Amit N. Vora, MD, MPH, an interventional cardiologist and researcher from Duke University Medical Center and the Duke Clinical Research Institute. "When you combine patients that had AFib prior to the TAVR procedure and those that develop it after, more than one-half of all patients undergoing TAVR have to also deal with co-existing AFib."

The study looked at data from the STS/ACC TVT Registry, a collaboration of the Society of Thoracic Surgeons and the American College of Cardiology, linked with outcomes data from the Centers for Medicare and Medicaid

Services. Researchers analyzed 13,356 patients undergoing TAVR at 381 sites across the U.S. From this group, 1,138 patients developed AFib for the first time after the procedure. The study focused on how often new AFib was occurring, how it was managed if it did happen, and what the outcomes were for patients who developed AFib after TAVR.

The analysis found that patients who developed new-onset AFib following TAVR were more likely to be female, older and have severe chronic obstructive pulmonary disease. TAVR that was not performed via transfemoral access was also shown to be associated with the development of new-onset Afib.

The study also examined short- and long-term outcomes among patients who developed new-onset AFib. Rates of in-hospital death, stroke and heart attack were all higher among new-onset AFib patients. Additionally, these patients were at a 37 percent higher risk of death one year after the TAVR procedure as well.

"Current guidelines are murky regarding the optimal treatment strategy for these patients, who often tend to be at high risk for stroke but also high risk for bleeding," Vora said. "Although there are a number of trials that are examining various strategies for this population, we need to continue to look very closely at this and determine the best care management for these high-risk patients."

Story Source:

Materials provided by **American College of Cardiology**. *Note: Content may be edited for style and length.*

Children born through IVF may have higher risk of hypertension: By age 16, premature vascular aging persists in apparently healthy adolescents -- ScienceDaily

Children conceived through assisted reproductive technologies may be at an increased risk of developing arterial hypertension early in life, among other cardiovascular complications, according to a Swiss study published today in the *Journal of the American College of Cardiology*.

Developed in 1978, assisted reproductive technologies (ART) has helped millions of individuals and families who cannot conceive naturally. The most common ART methods are in vitro fertilization and intracytoplasmic sperm injection, which can expose the gamete and embryo to a variety of environmental factors before implantation. Children conceived using ART make up 1.7 percent of all infants born in the United States every year and currently over six million persons worldwide.

The study authors assessed the circulatory system of 54 young, healthy ART adolescents (mean age 16) by measuring ambulatory blood pressure, as well as plaque build-up, blood vessel function and artery stiffness. Body mass index, birth weight, gestational age, and maternal BMI, smoking status and cardiovascular risk profile were similar between the ART adolescents and 43 age- and sex-matched control participants.

Through 24-hour ambulatory blood pressure monitoring, researchers discovered that ART adolescents had both a higher systolic and diastolic blood pressure than the control participants of natural conception at 119/71 mmHg versus 115/69, respectively. Most importantly, eight of the ART adolescents reached the criteria for the diagnosis of arterial hypertension (over 130/80 mmHg) whereas only one of the control participants met the

criteria.

"The increased prevalence of arterial hypertension in ART participants is what is most concerning," said Emrush Rexhaj, MD, director of Arterial Hypertension and Altitude Medicine at Inselspital, University Hospital in Bern, Switzerland and the lead author of the study. "There is growing evidence that ART alters the blood vessels in children, but the long-term consequences were not known. We now know that this places ART children at a six times higher rate of hypertension than children conceived naturally."

The authors also studied these participants five years before this study and found that the arterial blood pressure between ART and control children was not different.

"It only took five years for differences in arterial blood pressure to show," Rexhaj said. "This is a rapidly growing population and apparently healthy children are showing serious signs of concern for early cardiovascular risk, especially when it comes to arterial hypertension."

In an accompanying editorial, Larry A. Weinrauch, MD, cardiologist at Mount Auburn Hospital said that the study's small cohort may understate the importance of this problem for ART adolescents, especially since multiple birth pregnancies and maternal risk factors (such as eclampsia, chronic hypertension and diabetes) were excluded from the study.

"Early study, detection and treatment of ART conceived individuals may be the appropriate course of preventative action," Weinrauch said. "We need to be vigilant in the development of elevated blood pressure among children conceived through ART to implement early lifestyle-based modifications and, if necessary, pharmacotherapy."

Limitations of this study include that only single-birth children were studied, as well as that participants were recruited from one procreation center. Prematurity, low birth weight and preeclampsia (all known cardiovascular risk factors) were excluded from the study. These limitations may have resulted in a lower cardiovascular risk among the participants compared to the overall ART population.

Story Source:

Materials provided by **American College of Cardiology**. *Note: Content may be edited for style and length.*

Can social media networks reduce political polarization on climate change? -- ScienceDaily

Social media networks, which often foster partisan antagonism, may also offer a solution to reducing political polarization, according to new findings published in the *Proceedings of the National Academy of Sciences* from a team led by University of Pennsylvania sociologist Damon Centola.

The Penn researchers asked 2,400 Republicans and Democrats to interpret recent climate-change data on Arctic sea-ice levels. Initially, nearly 40 percent of Republicans incorrectly interpreted the data, saying that Arctic sea-ice levels were increasing; 26 percent of Democrats made the same mistake. However, after participants interacted in anonymous social media networks -- sharing opinions about the data and its meaning for future levels of Arctic sea ice -- 88 percent of Republicans and 86 percent of Democrats correctly analyzed it, agreeing that sea-ice levels were dropping.

Republicans and Democrats who were not permitted to interact with each other in social media networks but instead had several additional minutes to reflect on the climate data before updating their responses remained highly polarized and offered significantly less accurate forecasts.

"New scientific information does not change people's minds. They can always interpret it to match their beliefs," says Centola, director of Penn's Network Dynamics Group and author of the new book "How Behavior Spreads." "But, if you allow people to interact with each other in egalitarian social networks, in which no individual is more powerful than another, we find remarkably strong effects of bipartisan social learning on eliminating polarization."

To test this notion for politically charged topics like climate change, Centola, along with Penn doctoral student Douglas Guilbeault and recent Penn Ph.D.

graduate Joshua Becker, constructed an experimental social media platform, which they used to test how different kinds of social media environments would affect political polarization and group accuracy.

Their study was motivated by NASA's 2013 release of new data detailing historical trends in monthly levels of Arctic sea ice. "NASA found, to its dismay, that a lot of people were misinterpreting the graph to say that there would actually be more Arctic sea ice in the future rather than less," Guilbeault explains. "Conservatives in particular were susceptible to this misinterpretation."

The researchers wondered how social media networks might alter this outcome, so they randomly assigned participants to one of three experimental groups: a political-identity setup, which revealed the political affiliation of each person's social media contacts; a political-symbols setup, in which people interacted anonymously through social networks but with party symbols of the donkey and the elephant displayed at the bottom of their screens; and a non-political setup, in which people interacted anonymously. Twenty Republicans and 20 Democrats made up each social network.

Once randomized, every individual then viewed the NASA graph and forecasted Arctic sea-ice levels for the year 2025. They first answered independently, and then viewed peers' answers before revising their guesses twice more. The study outcomes surprised the researchers in several respects.

"We all expected polarization when Republicans and Democrats were isolated," says Centola, who is also an associate professor in Penn's Annenberg School for Communication and School of Engineering and Applied Sciences, "but we were amazed to see how dramatically bipartisan networks could improve participants' judgments." In the non-political setup, for example, polarization disappeared entirely, with more than 85 percent of participants agreeing on a future decrease in Arctic sea ice.

"But," Centola adds, "the biggest surprise -- and perhaps our biggest lesson -- came from how fragile it all was. The improvements vanished completely with the mere suggestion of political party. All we did was put a picture of an elephant and a donkey at the bottom of a screen, and all the social learning effects disappeared. Participants' inaccurate beliefs and high levels of

polarization remained."

That last finding reveals that even inconspicuous elements of a social media environment or of a media broadcast can hinder bipartisan communications. "Simple ways of framing a political conversation, like incorporating political iconography, can significantly increase the likelihood of polarization," Guilbeault says.

Instead, Centola says, put people into situations that remove the political backdrop. "Most of us are biased in one way or another. It's often unavoidable. But, if you eliminate the symbols that drive people into their political camps and let them talk to each other, people have a natural instinct to learn from one another. And that can go a long way toward lessening partisan conflict."

Funding for the research came, in part, from the Social Sciences and Humanities Research Council of Canada, a Robert Wood Johnson Foundation Pioneer Grant, and the National Institutes of Health's Tobacco Centers for Regulatory Control.

Infants can distinguish between leaders and bullies, study finds -- ScienceDaily

A new study finds that 21-month-old infants can distinguish between respect-based power asserted by a leader and fear-based power wielded by a bully.

The study, reported in the *Proceedings of the National Academy of Sciences*, analyzed infants' eye-gazing behavior, a standard approach for measuring expectations in children too young to explain their thinking to adults. This "violation-of-expectation" method relies on the observation that infants stare longer at events that contradict their expectations.

Previous studies had shown that infants can recognize power differences between two or more characters, said University of Illinois Psychology Alumni Distinguished Professor Renee Baillargeon, who conducted the new research.

"For example, infants will stare longer at scenarios where larger characters defer to smaller ones. They also take note when a character who normally wins a confrontation with another suddenly loses," she said. "But little was known about infants' ability to distinguish between different bases of power."

To get at this question, Baillargeon developed a series of animations depicting cartoon characters interacting with an individual portrayed as a leader, a bully or a likeable person with no evident power.

She first tested how adults -- undergraduate students at the University of Illinois -- responded to the scenarios and found that the adults identified the characters as intended. Next, she measured the eye-gazing behavior of infants as they watched the same animations.

"In one experiment, the infants watched a scenario in which a character portrayed either as a leader or a bully gave an order ("Time for bed!") to three protagonists, who initially obeyed," Baillargeon said. "The character then left

the scene and the protagonists either continued to obey or disobeyed."

The infants detected a violation when the protagonists disobeyed the leader but not when they disobeyed the bully, Baillargeon found. This was true also in a second experiment that repeated the scenarios but eliminated previous differences in physical appearance between the leader and the bully (see graphic).

A third experiment tested whether the infants were responding to the likeability of the characters in the scenarios, rather than to their status as leaders or bullies.

"In general, when the leader left the scene, the infants expected the protagonists to continue to obey the leader," Baillargeon said. "However, when the bully left, the infants had no particular expectation: The protagonists might continue to obey out of fear, or they might disobey because the bully was gone. The infants expected obedience only when the bully remained in the scene and could harm them again if they disobeyed.

"Finally, when the likeable character left, the infants expected the protagonists to disobey, most likely because the character held no power over them," Baillargeon said.

The new findings confirm earlier studies showing that infants can detect differences in power between individuals and expect those differences to endure over time, Baillargeon said.

"Our results also provide evidence that infants in the second year of life can already distinguish between leaders and bullies," she said. "Infants understand that with leaders, you have to obey them even when they are not around; with bullies, though, you have to obey them only when they are around."

Scientists engineer way to prevent immune response to gene therapy in mice -- ScienceDaily

Stanford University School of Medicine researchers have demonstrated that gene therapy can be effective without causing a dangerous side effect common to all gene therapy: an autoimmune reaction to the normal protein, which the patient's immune system is encountering for the first time.

The researchers showed this in a mouse model that accurately recapitulates Duchenne muscular dystrophy. One in every 5,000 boys is born with this crippling disease, which leaves patients wheelchair-bound by mid-adolescence and is typically fatal by young adulthood. It stems from a genetic defect that deprives skeletal and cardiac muscles of a working version of a protein called dystrophin.

"Gene therapy is on the cusp of becoming a mainstream approach for treating single-gene disorders," said Lawrence Steinman, MD, professor of neurology and neurological sciences and of pediatrics at Stanford. "But there's a catch: If you give a gene that's a recipe for a normal protein to someone with a faulty version of the gene, whose body never made the normal protein before, that person's immune system will mount a reaction -- in some cases, a lethal one -- to the normal protein, just as it would to any foreign protein. We think we've solved that problem."

The findings are described in a study to be published online Sept. 3 in the *Proceedings of the National Academy of Sciences*. Steinman, who holds the George A. Zimmermann Professorship, is the study's senior author. The lead author is senior research scientist Peggy Ho, PhD.

Going viral

Duchenne muscular dystrophy is the result of a single defective gene, making

it an excellent candidate for gene therapy in which a patient's faulty gene is replaced with the correct version. One way to do this is by co-opting viruses, which are simple entities that are adept at infecting cells and then forcing every invaded cell's reproductive machinery to copy their own viral genes. For gene therapy, viruses are modified by ridding them of unwanted genes, retaining the ones necessary for infectivity and adding the therapeutic gene to be delivered to a patient.

The gene encoding dystrophin is far too big for a gene-hauling virus to take onboard. Fortunately, a mere fraction of the entire gene is enough to generate a reasonably functional version of dystrophin, called microdystrophin. The abridged gene fits snugly into a viral delivery vehicle designed some time ago by Jeffrey Chamberlain, PhD, a co-author of the study and a professor of neurology, medicine and biochemistry at the University of Washington.

Inducing tolerance

But there's still that sticky autoimmunity problem. To get around it, Steinman and his colleagues spliced the gene for microdystrophin into a different kind of delivery vehicle called a plasmid.

Plasmids are tiny rings of DNA that bacteria often trade back and forth to disseminate important traits, such as drug resistance, among one another. The particular bacterial plasmid the investigators co-opted ordinarily contains several short DNA sequences, or motifs, that the immune system recognizes as suspicious and to which it mounts a strong response.

But some years ago, Steinman and a few other Stanford scientists -- including Ho and study co-author William Robinson, MD, PhD, professor of immunology and rheumatology -- figured out how to replace those troublesome DNA motifs with another set of DNA sequences that, far from exacerbating the immune response, subdue it. This immune-tolerance-inducing plasmid has been deployed in clinical trials for two different autoimmune conditions, with promising results.

For the new study, the researchers used a one-two punch to deliver gene therapy and protection against autoimmunity to the mice: viral delivery of the microdystrophin gene, followed by the plasmid-assisted induction of

tolerance to microdystrophin.

Fifteen 6-week-old mice -- an age roughly equivalent to that of a young child -- bioengineered to lack functioning dystrophin were injected with the virus carrying microdystrophin. Starting a week later, they were divided into three groups and given weekly injections for 32 weeks of either a dummy solution; the dummy solution plus the tolerance-inducing plasmid absent the microdystrophin gene; or the plasmid with the microdystrophin gene.

At the end of the 32-week period, by which time the mice were the human equivalent of young adults, the ones that got the microdystrophin-loaded plasmid had significantly greater muscular strength and substantially more dystrophin-producing muscle fibers. They had lower levels of key bloodborne signaling chemicals that carry inflammatory messages between immune cells, and they had weakened antibody responses to normally immunogenic portions of microdystrophin.

"It's still early days here -- this was, after all, a mouse experiment -- but it seems we can induce tolerance to a wide assortment of formerly immunogenic proteins by inserting the gene for the protein of interest into the plasmid," Steinman said. "We've seen this with the insulin precursor, in people who have Type 1 diabetes, and with myelin, in people who have multiple sclerosis. It now looks as if the concept may hold for gene therapy, too."

Lack of social mobility more of an 'occupational hazard' than previously known -- ScienceDaily

American workers' occupational status reflects that of their parents more than previously known, reaffirming more starkly that the lack of mobility in the United States is in large part due to the occupation of our parents, finds a new study by New York University's Michael Hout.

"A lot of Americans think the U.S. has more social mobility than other western industrialized countries," explains Hout, a sociology professor. "This makes it abundantly clear that we have less."

Previous research had used occupation metrics that relied on averages to gauge social status across generations. This dynamic, also called "intergenerational persistence," is the degree to which one generation's success depends on their parents' resources.

While these studies showed a strong association between parental occupation and intergenerational persistence, they understated the significance of parents' jobs on the status of their children.

The new findings, which appear in the journal *Proceedings of the National Academy of Sciences*, reveal a more powerful link as they rely on data that use medians, or middle points, as opposed to average socioeconomic status, in gauging occupations.

The findings, which take into account pay and education of those in a given occupation, are based on General Social Survey (GSS) data from 1994 through 2016.

To measure occupation, GSS interviewers asked respondents for detailed descriptions of their current occupation, their father's occupation when they

were growing up, and (since 1994) their mother's occupation while they were growing up. Their replies were coded to 539 occupational categories, following protocols established by the U.S. Census Bureau, and then given a socioeconomic score ranging from 9 (shoe shiner) to 53 (flight attendant) to 93 (surgeon).

"The underlying idea is that some occupations are desirable and others less so," explains Hout.

Notably, the study shows that the sons and daughters of high-status parents have more advantages in the labor force than earlier estimates suggested.

For example, half the sons and daughters whose parents were in the top tier of occupations now work in occupations that score 76 or higher (on a 100-point scale) while half the sons and daughters of parents from the bottom tier now work in occupations that score 28 or less on that scale.

Hout notes that earlier measures -- tracking averages instead of medians -- would underestimate that range and show less stark distinctions between the top and bottom tiers of occupation status.

Specifically, in the above instance, using averages would show half the sons and daughters whose parents were in the top tier of occupations work in occupations that score only 72 or higher while half the sons and daughters of parents from the bottom tier work in occupations that score up to 33 or less.

"Your circumstances at birth -- specifically, what your parents do for a living -- are an even bigger factor in how far you get in life than we had previously realized," observes Hout. "Generations of Americans considered the United States to be a land of opportunity. This research raises some sobering questions about that image."

The research was supported, in part, by a grant from the National Science Foundation (SES-16-1458922).

Story Source:

Materials provided by **New York University**. *Note: Content may be edited*

for style and length.

Neutrophil nanosponges soak up proteins that promote rheumatoid arthritis -- ScienceDaily

Engineers at the University of California San Diego have developed neutrophil "nanosponges" that can safely absorb and neutralize a variety of proteins that play a role in the progression of rheumatoid arthritis. Injections of these nanosponges effectively treated severe rheumatoid arthritis in two mouse models. Administering the nanosponges early on also prevented the disease from developing.

The work is published Sept. 3 in *Nature Nanotechnology*.

"Nanosponges are a new paradigm of treatment to block pathological molecules from triggering disease in the body," said senior author Liangfang Zhang, a nanoengineering professor at the UC San Diego Jacobs School of Engineering. "Rather than creating treatments to block a few specific types of pathological molecules, we are developing a platform that can block a broad spectrum of them, and this way we can treat and prevent disease more effectively and efficiently."

This work is one of the latest examples of therapeutic nanosponges developed by Zhang's lab. Zhang, who is affiliated with the Institute of Engineering in Medicine and Moores Cancer Center at UC San Diego, and his team previously developed red blood cell nanosponges to combat and prevent MRSA infections and macrophage nanosponges to treat and manage sepsis.

The new nanosponges are nanoparticles of biodegradable polymer coated with the cell membranes of neutrophils, a type of white blood cell.

Neutrophils are among the immune system's first responders against invading pathogens. They are also known to play a role in the development of rheumatoid arthritis, a chronic autoimmune disease that causes painful

inflammation in the joints and can ultimately lead to damage of cartilage and bone tissue.

When rheumatoid arthritis develops, cells in the joints produce inflammatory proteins called cytokines. Release of cytokines signals neutrophils to enter the joints. Once there, cytokines bind to receptors on the neutrophil surfaces, activating them to release more cytokines, which in turn draws more neutrophils to the joints and so on.

The nanosponges essentially nip this inflammatory cascade in the bud. By acting as tiny neutrophil decoys, they intercept cytokines and stop them from signaling even more neutrophils to the joints, reducing inflammation and joint damage.

These nanosponges offer a promising alternative to current treatments for rheumatoid arthritis. Some monoclonal antibody drugs, for example, have helped patients manage symptoms of the disease, but they work by neutralizing only specific types of cytokines. This is not sufficient to treat the disease, said Zhang, because there are so many different types of cytokines and pathological molecules involved.

"Neutralizing just one or two types might not be as effective. So our approach is to take neutrophil cell membranes, which naturally have receptors to bind all these different types of cytokines, and use them to manage an entire population of inflammatory molecules," said Zhang.

"This strategy removes the need to identify specific cytokines or inflammatory signals in the process. Using entire neutrophil cell membranes, we're cutting off all these inflammatory signals at once," said first author Qiangzhe Zhang, a Ph.D. student in Professor Liangfang Zhang's research group at UC San Diego.

To make the neutrophil nanosponges, the researchers first developed a method to separate neutrophils from whole blood. They then processed the cells in a solution that causes them to swell and burst, leaving the membranes behind. The membranes were then broken up into much smaller pieces. Mixing them with ball-shaped nanoparticles made of biodegradable polymer fused the neutrophil cell membranes onto the nanoparticle surfaces.

"One of the major challenges of this work was streamlining this entire process, from isolating neutrophils from blood to removing the membranes, and making this process repeatable. We spent a lot of time figuring this out and eventually created a consistent neutrophil nanosponge production line," said Qiangzhe Zhang.

In mouse models of severe rheumatoid arthritis, injecting nanosponges in inflamed joints led to reduced swelling and protected cartilage from further damage. The nanosponges performed just as well as treatments in which mice were administered a high dose of monoclonal antibodies.

The nanosponges also worked as a preventive treatment when administered prior to inducing the disease in another group of mice.

Professor Liangfang Zhang cautions that the nanosponge treatment does not eliminate the disease. "We are basically able to manage the disease. It's not completely gone. But swelling is greatly reduced and cartilage damage is minimized," he said.

The team hopes to one day see their work in clinical trials.

Now we can see brain cells 'talk' and that will shed light on neurological diseases -- ScienceDaily

Scientists have developed a way to see brain cells talk -- to actually see neurons communicate in bright, vivid color. The new lab technique is set to provide long-needed answers about the brain and neurological diseases such as Alzheimer's disease, schizophrenia and depression. Those answers will facilitate new and vastly improved treatments for conditions that have largely resisted scientists' efforts to understand them.

"Before we didn't have any way to understand how [such neurotransmissions] work," said researcher J. Julius Zhu, PhD, of the University of Virginia School of Medicine. "In the case of Alzheimer's, in particular, we spent billions of dollars and we have almost no effective treatment. ... Now, for the first time, we can see what is happening."

Understanding Neurological Diseases

To demonstrate the technique's effectiveness, Zhu's team in Charlottesville and colleagues in China have used it to visualize a poorly understood neurotransmitter called acetylcholine. "Acetylcholine has an important role in how we behave because it affects our memory and mood," Zhu explained. "It affects Alzheimer's, schizophrenia, emotions, depression, all kind of emotion-related diseases and mental problems." (Acetylcholine also plays critical roles elsewhere in the body, such as regulating insulin secretion in the pancreas and in controlling stress and blood pressure.)

Drugs designed to combat Alzheimer's disease actually inhibit acetylcholinesterase, an enzyme that degrades acetylcholine, to boost the effect of diminishing acetylcholine released in the brain, Zhu said. But doctors haven't fully understood how the drugs work, and there's been no way to determine just how much inhibition is needed. "These drugs are not very

effective," he said. "They only offer a minor improvement, and once you stop the drug [the symptoms] just seem much worse. So probably in trying to treat these patients, you temporarily enhance them but you actually make them even worse."

By being able to see acetylcholine and other neurotransmitters in action in fluorescent color, doctors will be able to establish a baseline for good health and then work to restore that in patients with neurological diseases.

"We want to first measure how [the neurotransmitters] normally do the job. We've already found that there are acetylcholine transmissions very different from what we would expect," said Zhu, of UVA's Department of Pharmacology. "Then we also want to find how the patient differs. That comparison will provide us important answers."

Story Source:

Materials provided by **University of Virginia Health System**. *Note: Content may be edited for style and length.*

New research shows how children want their food served -- ScienceDaily

The aim of the research from Future Consumer Lab was to investigate whether children prefer their food served in a particular way and whether their gender and age make a difference with regard to their preferences.

'As a researcher, I have anecdotally heard parents say that their children prefer to have their food served in a particular way, including in a specific order. But we do not have much evidence-based knowledge about how children sort and eat their food, which is very relevant when, for example, we want our children to eat more vegetables -- or eat their food in general,' says Associate Professor Annemarie Olsen from Future Consumer Lab, at the Department of Food Science at the University of Copenhagen.

In addition to being a helping hand for parents, the research can be used to optimise meal programmes in schools and meals that are delivered to pupils by external suppliers.

Big gains with little effort

We already know that you can get children to eat more fruits and vegetables just by presenting them in small portions and making them freely available, so you can easily grab them and eat them. We also know that the visual presentation affects how much children eat.

'At the same time, it would be nice to know whether there are big gains to be made just by arranging food on the plate in a certain way,' says Annemarie Olsen.

100 children ranked food according to their preferred serving style

The researchers asked 100 schoolchildren, aged 7-8 and 12-14 years, to make a priority list of photos of six different dishes served in three different ways:

1. With the elements of the food presented separately so they did not touch each other
2. As a mix of separate ingredients and ingredients that were mixed together
3. With all the food mixed together

From the children's prioritisation of the displayed photos, the researchers could see which presentation of the food they liked best and which serving style they least cared for. The study shows that the younger girls (aged 7-8) prefer the separate serving style, while boys of the same age do not have a preference for how the food is arranged. The research also shows that children between 12 and 14 prefer food to be either mixed together or served as a mix of separate and mixed-together ingredients.

A separated serving style is the best solution

The research does not say why younger girls prefer to have their food served as separate ingredients.

'One suggestion could be that they believe that the different ingredients could contaminate each other. But it could also be that they prefer to eat the different elements in a certain order or that the clear delineation just provides a better overview,' says Annemarie Olsen, who, based on the research, advises that you serve food separated on the plate -- at least when it comes to the younger age groups.

'The child can mix the food when the various elements of the food are separated on the plate, while the reverse is not possible,' she says.

Story Source:

Materials provided by **Faculty of Science - University of Copenhagen**.
Note: Content may be edited for style and length.

Technology News

Top stories featured on ScienceDaily's Space & Time, Matter & Energy, and Computers & Math sections.

- **High precision microbial population dynamics under cycles of feast and famine** [周三, 05 9月 04:45]
  Scientists have produced the most precise picture to date of population dynamics in fluctuating feast-or-famine conditions. Biological physicists found that bacterial population density is a function of both the frequency and the amplitude of nutrient fluctuations.
- **Ultracold atoms used to verify 1963 prediction about 1D electrons** [周三, 05 9月 03:03]
  Atomic physicists have verified a key prediction from a 55-year-old theory about one-dimensional electronics that is increasingly relevant thanks to Silicon Valley's inexorable quest for miniaturization.
- **New smart materials could open new research field** [周三, 05 9月 02:06]
  A group of new smart materials has the potential to significantly improve the efficiency of fuel burn in jet engines, cutting the cost of flying. The materials, which could also reduce airplane noise over residential areas, have additional applications in a variety of other industries.
- **State-of-the-art imaging techniques reveal heightened detail and beauty of vertebrate life** [周三, 05 9月 02:06]
  A mingling of science and art, the next-generation photographs of vertebrate skeletons are at once fascinating, eerie, intricate and exquisite.
- **Peering into private life of atomic clusters -- using the world's tiniest test tubes** [周三, 05 9月 02:06]
  Researchers have achieved time-resolved imaging of atomic-scale dynamics and chemical transformations promoted by metal nanoclusters.
- **Measuring the nanoworld** [周三, 05 9月 02:05]
  Researchers establish a benchmark for accurate determination of internal dimensions within individual molecules.
- **New technology improves hydrogen manufacturing** [周三, 05 9月 02:05]
  Researchers have demonstrated high-performance electrochemical hydrogen production at a lower temperature than had been possible before.

- **AI beats doctors at predicting heart disease deaths** [周三, 05 9月 02:05]
  A model developed using artificial intelligence is better at predicting risk of death in patients with heart disease than models designed by medical experts, a new study shows.
- **A quantum gate between atoms and photons may help in scaling up quantum computers** [周二, 04 9月 23:47]
  The quantum computers of the future will be able to perform computations that cannot be done on today's computers. These may likely include the ability to crack the encryption that is currently used for secure electronic transactions, as well as the means to efficiently solve unwieldy problems in which the number of possible solutions increases exponentially.
- **Boosting gravitational wave detectors with quantum tricks** [周二, 04 9月 23:47]
  A group of scientists will soon start developing a new line of technical equipment in order to dramatically improve gravitational wave detectors. If the scientists are able to improve the gravitational wave detectors as much as they 'realistically expect can be done,' the detectors will be able to monitor and carry out measurements in an eight times bigger volume of space than what is currently possible.
- **Quantum weirdness in 'chicken or egg' paradox** [周二, 04 9月 23:47]
  The 'chicken or egg' paradox was first proposed by philosophers in Ancient Greece to describe the problem of determining cause-and-effect. Now, a team of physicists has shown that, as far as quantum physics is concerned, the chicken and the egg can both come first.
- **Telescope maps cosmic rays in Large and Small Magellanic Clouds** [周二, 04 9月 23:47]
  A radio telescope in outback Western Australia has been used to observe radiation from cosmic rays in two neighbouring galaxies, showing areas of star formation and echoes of past supernovae.
- **Simulations reveal role of calcium in titanium implant acceptance** [周二, 04 9月 23:47]
  Titanium-based materials are widely used in medical implant technology, and coating the surface of titanium materials with biologically active molecules has recently shown promise to improve how cells adhere to implants. The mechanisms behind how peptides stick to titanium, however, are not fully understood. Researchers have now found how calcium ions present at the interface between titanium oxide and tissues affect how well peptides bind to the metal.
- **Veiled supernovae provide clue to stellar evolution** [周二, 04 9月 22:32]
  At the end of its life, a red supergiant star explodes in a hydrogen-rich supernova. By comparing observation results to simulation models, an international research team found that in many cases this explosion takes place inside a thick cloud of circumstellar matter shrouding the star. This result completely changes our understanding of the last stage of stellar evolution.
- **Satellites more at risk from fast solar wind than a major**

space storm [周二, 04 9月 22:32]
Satellites are more likely to be at risk from high-speed solar wind than a major geomagnetic storm according to a new study.

- **Superradiance: Quantum effect detected in tiny diamonds** [周二, 04 9月 22:32]
An atom gives off energy and causes many other atoms in its vicinity to emit light as well. This phenomenon is called 'superradiance'. For the first time, this phenomenon has now bean measured in a solid-state system, consisting of tiny diamonds with built-in nitrogen atoms.

- **Cathode fabrication for oxide solid-state batteries at room temperature** [周二, 04 9月 22:32]
Researchers have successfully fabricated a lithium trivanadate (LVO) cathode thick film on a garnet-type oxide solid electrolyte using the aerosol deposition method. The LVO cathode thick-film fabricated on the solid electrolyte showed a large reversible charge and discharge capacity as high as 300 mAh/g and a good cycling stability at 100 ºC. This finding may contribute to the realization of highly safe and chemically stable oxide-based all-solid-state lithium batteries.

- **Artificial cells are tiny bacteria fighters** [周二, 04 9月 21:37]
Newly created artificial cells can kill bacteria.

- **Biophysics: Self-centered** [周二, 04 9月 20:51]
Rod-shaped bacterial cells normally divide by constriction midway along their long axis. Physicists have developed a theoretical model to explain how Myxococcus xanthus localizes the plane of division to mid-cell.

- **Falling stars hold clue for understanding dying stars** [周二, 04 9月 01:59]
An international team of researchers has proposed a new method to investigate the inner workings of supernovae explosions. This new method uses meteorites and is unique in that it can determine the contribution from electron anti-neutrinos, enigmatic particles which can't be tracked through other means.

- **Neutrophil nanosponges soak up proteins that promote rheumatoid arthritis** [周一, 03 9月 23:34]
Engineers have developed neutrophil 'nanosponges' that can safely absorb and neutralize a variety of proteins that play a role in the progression of rheumatoid arthritis. Injections of these nanosponges effectively treated severe rheumatoid arthritis in two mouse models. Administering the nanosponges early on also prevented the disease from developing. The nanosponges are nanoparticles of biodegradable polymer coated with the cell membranes of neutrophils, a type of white blood cell.

- **Terahertz spectroscopy enters the single-molecule regime** [周一, 03 9月 23:34]
Researchers showed that long-wavelength terahertz (THz) spectroscopy can detect motion of single molecules, not just molecular ensembles. They used a single-molecule transistor design, where pairs of metal electrodes trap isolated C60 molecules, focus the THz beam onto them, and measure current

change caused by THz-induced oscillation. Two vibrational peaks were recorded. The measurement was sensitive enough to register slight peak-splitting caused by electron charging. This could promote wider u…

- **Scientists pioneer a new way to turn sunlight into fuel** [周一, 03 9月 23:33]
  A new study used semi-artificial photosynthesis to explore new ways to produce and store solar energy. They used natural sunlight to convert water into hydrogen and oxygen using a mixture of biological components and human-made technologies.

- **Little star sheds light on young planets** [周一, 03 9月 22:17]
  Astronomers discovered a dense disk of material around a young star, which may be a precursor to a planetary system. Their research could vastly improve models of how solar systems form, which would tell us more about our own place in the cosmos.

- **A new way to remove ice buildup without power or chemicals** [周六, 01 9月 03:01]
  Researchers have found a way to prevent icing of powerlines, airplanes, wind turbines, and other surfaces with a special coating and the power of sunlight -- no heating or harsh chemicals needed.

- **Sound can be used to print droplets that couldn't be printed before** [周六, 01 9月 03:01]
  Researchers have developed a new printing technology that uses sound waves to control the size of liquid droplets independent of fluid viscosity. This approach could greatly broaden the types of liquids, including biopharmaceuticals, that can be printed drop-on-demand. The researchers used sound waves to generate a highly confined force at the tip of the printer nozzle, which pulls the droplet. The higher the amplitude of the sound waves, the smaller the droplet size.

- **Better silicone adhesion Inspired by beetle feet** [周五, 31 8月 23:04]
  A research team has succeeded in boosting the adhesive effect of a silicone material significantly inspired by the structure of beetle feet. In addition, they found out that the adhesiveness of the structured material changes drastically, if it is bent to varying degrees. Their results could be interesting for the development of tiny robots and gripping devices.

- **The low impact of the high-speed train on international tourism** [周五, 31 8月 23:04]
  There is undeniably a complementary relationship between air travel and the high-speed train. However, and although both means of transport favor tourism, European experience indicates that their influence is very different.

- **Cannibalistic materials feed on themselves to grow new nanostructures** [周五, 31 8月 23:04]
  Scientists have induced a two-dimensional material to cannibalize itself for atomic 'building blocks' from which stable structures formed. The findings provide insights that may improve design of 2-D materials for fast-charging energy-storage and electronic devices.

- **Water worlds could support life, study says** [周五, 31 8月 20:35]
  The conditions for life surviving on planets entirely covered in water are more fluid than previously thought, opening up the possibility that water worlds could be habitable, according to a new article.
- **Model can more naturally detect depression in conversations** [周五, 31 8月 06:01]
  Researchers detail a neural-network model that can be unleashed on raw text and audio data from interviews to discover speech patterns indicative of depression. Given a new subject, it can accurately predict if the individual is depressed, without needing any other information about the questions and answers.
- **Using physics to predict crowd behavior** [周五, 31 8月 06:01]
  Electrons whizzing around each other and humans crammed together at a political rally don't seem to have much in common, but researchers are connecting the dots. They've developed a highly accurate mathematical approach to predict the behavior of crowds of living creatures, using methods originally developed to study large collections of quantum mechanically interacting electrons.
- **Countries ranked by oil production emissions** [周五, 31 8月 06:01]
  Emissions associated with oil and gas production are a significant source of greenhouse gases. A new analysis ranks countries by emission levels and identifies the major sources of emissions, a first step toward policy to regulate oil and gas production practices.
- **Dual-layer solar cell sets record for efficiently generating power** [周五, 31 8月 06:00]
  Materials scientists have developed a highly efficient thin-film solar cell that generates more energy than typical solar panels, thanks to its double-layer design.
- **Scientists predict superelastic properties in a group of iron-based superconductors** [周五, 31 8月 06:00]
  Researchers have computationally predicted a number of unique properties in a group of iron-based superconductors, including room-temperature super-elasticity.
- **Injection wells can induce earthquakes miles away from the well** [周五, 31 8月 02:32]
  A study of earthquakes induced by injecting fluids deep underground has revealed surprising patterns, suggesting that current recommendations for hydraulic fracturing, wastewater disposal, and geothermal wells may need to be revised.
- **DNA accessibility, gene expression jointly profiled in thousands of cells** [周五, 31 8月 02:32]
  A new assay can concurrently trace, in thousands of different cells, the marks that shape what each cell's genome will do -- the epigenome -- and the copies of the instructions themselves -- the transcriptome. The epigenome and transcriptome are part of the molecular biology that converts the

genetic blueprint of DNA into tools and materials for living cells.

- **Researchers are turning to deadly venoms in their quests for life-saving therapies** [周五, 31 8月 02:31]
  Scientists detail how technology and a growing understanding of the evolution of venoms are pointing the way toward entirely new classes of drugs capable of treating diabetes, autoimmune diseases, chronic pain, and other conditions.

- **Pushing big data to rapidly advance patient care** [周五, 31 8月 02:30]
  The breakneck pace of biomedical discovery is outstripping clinicians' ability to incorporate this new knowledge into practice. Scientists have now written about a possible way to approach this problem, one that will accelerate the movement of newly-generated evidence about the management of health and disease into practice that improves the health of patients.

- **Information technology jobs outpace most other jobs in productivity and growth since 2004** [周五, 31 8月 00:22]
  Jobs in information technology -- like computer software, big data, and cybersecurity -- are providing American workers with long-lasting financial stability, suggests a new study.

- **Catalyst advance could lead to economical fuel cells** [周五, 31 8月 00:22]
  Researchers have developed a new way to make low-cost, single-atom catalysts for fuel cells -- an advance that could make important clean energy technology more economically viable.

- **Solar eruptions may not have slinky-like shapes after all** [周四, 30 8月 23:30]
  As the saying goes, everything old is new again. While the common phrase often refers to fashion, design, or technology, scientists have found there is some truth to this mantra even when it comes to research. Revisiting some older data, the researchers discovered new information about the shape of coronal mass ejections (CMEs) -- large-scale eruptions of plasma and magnetic field from the sun -- that could one day help protect satellites in space as well as the electrical grid on Earth.

- **Nonlinear ghost imaging: Research could lead to better security scanners** [周四, 30 8月 23:30]
  Using a single pixel camera and terahertz electromagnetic waves, physicists have devised a novel imaging concept -- called nonlinear ghost imaging -- that could lead to the development of better airport scanners capable of detecting explosives.

- **New method for hydroboration of alkynes: Radicals induce unusual selectivity** [周四, 30 8月 21:54]
  A combination of organoboron and radical chemistry generates unusual trans-selectivity in hydroboration of alkynes. The use of N-heterocyclic carbene boranes is key to the success of this chemical transformation. This study is expected to open the door to the development of new boron-containing materials.

- **Introducing high-performance non-fullerene organic**

solar cells [周四, 30 8月 21:54]
An team of researchers has introduced a novel method that can solve issues associated with the thickness of the photoactive layers in OSCs.

- **Genetically encoded sensor tracks changes in oxygen levels with very high sensitivity** [周四, 30 8月 21:54]
  Based on a protein from E. coli, scientists have developed a fluorescent protein sensor able to provide real-time information on dynamic changes in oxygen levels with very high sensitivity. As the oxygen level is a major determinant of cellular function, the idea behind this sensor may revolutionize our ability to detect cellular changes of critical importance, such as in tumors and following stroke and heart attack.

- **Friction loss at first contact: The material does not forgive** [周四, 30 8月 21:54]
  Wear has major impacts on everything from the bearing of a wind power plant to an artificial hip joint. However, the exact cause of wear is still unclear. Scientists now show that the effect occurs at the first contact and always takes place at the same point of the material.

- **Artificial intelligence guides rapid data-driven exploration of underwater habitats** [周四, 30 8月 21:53]
  Researchers aboard Schmidt Ocean Institute's research vessel Falkor used autonomous underwater robots, along with the Institute's remotely operated vehicle (ROV) SuBastian, to acquire 1.3 million high resolution images of the seafloor at Hydrate Ridge, composing them into the largest known high resolution color 3D model of the seafloor. Using unsupervised clustering algorithms, they identified dynamic biological hotspots in the image data for more detailed surveys and sampling by a remotely opera…

- **'Blink' and you won't miss amyloids** [周四, 30 8月 21:53]
  Tiny protein structures called amyloids are key to understanding certain devastating age-related diseases, but they are so minuscule they can't be seen using conventional microscopic methods. A team of engineers has developed a new technique that uses temporary fluorescence, causing the amyloids to flash or 'blink', allowing researchers to better spot these problematic proteins.

- **Robotic herding of a flock of birds using drones** [周四, 30 8月 21:53]
  Researchers made a new algorithm for enabling a single robotic unmanned aerial vehicle to herd a flock of birds away from a designated airspace. This novel approach allows a single autonomous quadrotor drone to herd an entire flock of birds away without breaking their formation.

High precision microbial population dynamics under cycles of feast and famine: Automated sampling and measuring provides around-the-clock data collection -- ScienceDaily

Scientists at the University of Illinois at Urbana-Champaign have produced the most precise picture to date of population dynamics in fluctuating feast-or-famine conditions. Professor Seppe Kuehn, a biological physicist, and his graduate student Jason Merritt found that bacterial population density is a function of both the frequency and the amplitude of nutrient fluctuations. They found that the more frequent the feast cycles and the longer a feast cycle, the more rapid the population recovery from a famine state. This result has important implications for understanding how microbial populations cope with the constant nutrient fluctuations they experience in nature.

The team's findings were made possible by extraordinarily precise measurements of population dynamics in bacterial communities. The measurement, based on automated imaging of hundreds of millions of single cells, allowed the team to capture population dynamics over periods of more than a week with a temporal resolution of one minute. Those numbers and the extended duration of the experiment couldn't have happened without Merritt's continuous-culture systems, coupled to automated-sampling fluorescence microscopes.

These findings are published in the August 28 issue of *Physical Review Letters*.

The experimental setup took about two years and many prototypes to develop. Merritt built six identical systems for the experiment, each one automated to continuously pump in fresh media and pump out bacterial cultures for sampling. The samples were continuously imaged to track

changes in population density and structure. Software developed by Merritt automatically segments images to count bacterial cells, producing massive data sets. The software takes advantage of machine learning to resolve otherwise difficult-to-solve problems in image recognition and processing.

Kuehn comments, "Scientists studying populations of bacteria typically take samples manually and do their counting offline, in person. What Jason's systems do is automatically remove a sample, pass it in front of a microscope to be imaged, and then put it back. And they do that once a minute, 24 hours a day, with no input, for up to a month. His software counts the cells in the images, extracting information in real time."

He continues, "So that's a big step forward -- this has never been achieved before. Short-timescale quantitative studies have been done using microfluidic devices, but these are limited to about three days' runtime. We can run for 30 days, producing long-timescale highly quantitative measurements. We can easily run replicate experiments, reproducing the same results. Because of this, we were able to use the system to test hypotheses about the underlying mechanisms governing the dynamics we observed."

Merritt comments, "The idea for the system grew out of previous work Seppe had done. The device I built is basically a metal block with glass vials within it. The most important part of our system and the part that was the most difficult to get to work reliably is the coupling to a fluorescence microscope."

The system continuously draws samples out of the liquid culture into flexible tubing and then into a thin glass capillary in the path of the microscope. The bacteria pass through the capillary many at a time, but are spaced apart from one another. The biggest challenge overall was on the software side, doing proper image segmentation to convert the images to data.

The main finding, that populations apparently recovery faster from more frequent or larger pulses of nutrients, puzzled the team at first. However, the precision of the measurement allowed them to uncover the mechanism.

Merritt continues, "What we found out is that the fast recovery rates for the planktonic population are driven by dispersal from aggregated cells

(biofilms) during feast conditions. So basically when there's a lot of food, these cell aggregates start shedding cells rapidly, and the cells that shed off start growing rapidly. But during famine conditions when there's not very much food, these cells start coming back together and forming the aggregates again. This is the mechanism driving the frequency and amplitude dependence."

Kuehn adds, "Variations in a natural population may be the result of any one or a combination of many different variables -- the amount of nutrients, temperature, competition and predation, etc. -- so it's difficult to measure cause and effect. In the lab, we tightly control all of the parameters of our experiment. And now we can make a really robust and reproducible quantitative measurement. Going forward, we would like to modify these systems to study topics in evolutionary history. We also plan to do studies in which we use feedback control of microbial communities, to see whether we can push the communities back into a particular state. These are studies that wouldn't be possible without an automated system like the one we used in this study."

Ultracold atoms used to verify 1963 prediction about 1D electrons: Theory is increasingly relevant to chipmakers -- ScienceDaily

Rice University atomic physicists have verified a key prediction from a 55-year-old theory about one-dimensional electronics that is increasingly relevant thanks to Silicon Valley's inexorable quest for miniaturization.

"Chipmakers have been shrinking feature sizes on microchips for decades, and device physicists are now exploring the use of nanowires and nanotubes where the channels that electrons pass through are almost one-dimensional," said Rice experimental physicist Randy Hulet. "That's important because 1D is a different ballgame in terms of electron conductance. You need a new model, a new way of representing reality, to make sense of it."

With IBM and others committed to incorporating one-dimensional carbon nanotubes into integrated circuits, chip designs will increasingly need to account for 1D effects that arise from electrons being fermions, antisocial particles that are unwilling to share space.

The 1D implications of this standoffishness caught the attention of physicists Sin-Itiro Tomonaga and J.M. Luttinger, whose model of 1D electron behavior was published in 1963. A key prediction of Tomonaga-Luttinger liquid (TLL) theory is that exciting one electron in a 1D wire leads to a collective, organized response from every electron in the wire.

Stranger still, because of this collective behavior, TLL theory predicts that a moving electron in 1D will seemingly split in two and travel at different speeds, despite the fact that electrons are fundamental particles that have no constituent parts. This strange breakup, known as spin-charge separation, instead involves two inherent properties of the electron -- negative charge and

angular momentum, or "spin."

In a study online this week in *Physical Review Letters*, Hulet, University of Geneva theoretical physicist Thierry Giamarchi and their colleagues used another type of fermion -- ultracold lithium atoms cooled to within 100 billionths of a degree of absolute zero -- to both verify the predicted speed that charge waves move in 1D and offer confirmation that 1D charge waves increase their speed in proportion to the strength of the interaction between them.

"In a one-dimensional wire, electrons can move to the left or to the right, but they cannot go around other electrons," said Hulet, Rice's Fayez Sarofim Professor of Physics. "If you add energy to the system, they move, but because they're fermions and can't share space, that movement, or excitation, causes a kind of chain reaction.

"One electron moves, and it nudges the next one to move and the one next to that one and so on, causing the energy you've added to move down the wire like a wave," Hulet said. "That single excitation has created a ripple everywhere in the wire."

In their experiments, Hulet's team used lithium atoms as stand-ins for electrons. The atoms are trapped and slowed with lasers that oppose their motion. The slower they go, the colder the lithium atoms become, and at temperatures far colder than any in nature, the atoms behave like electrons. More lasers are used to form optical waveguides, one-dimensional tubes wide enough for just one atom. Despite the effort needed to create these conditions, Hulet said the experiments offer a big advantage.

"We can use a magnetic field in our experiment to tune the strength of the repulsive interaction between the lithium atoms," Hulet said. "In studying these collective, or correlated electron behaviors, interaction strength is an important factor. Stronger or weaker electron interactions can produce wholly different effects, but it's extraordinarily difficult to study this with electrons because of the inability to directly control interactions. With ultracold atoms, we can essentially dial the interaction strength to any level we want and watch what happens."

While previous groups have measured the speed of collective waves in nanowires and in gases of ultracold atoms, none had measured it as a function of interaction strength, Hulet said.

"Charge excitations are predicted to move faster with increasing interaction strength, and we showed that," he said. "Thierry Giamarchi, who literally wrote the book on this topic, used TLL theory to predict how the charge wave would behave in our ultracold atoms, and his predictions were borne out in our experiments."

Having that ability to control interactions also sets the stage for testing the next TLL prediction: The speed of charge waves and spin waves diverge with increasing interaction strength, meaning that as electrons are made to repel one another with greater force, charge waves will travel faster and spin waves will travel slower.

Now that the team has verified the predicted behavior of charge waves, Hulet said they next plan to measure spin waves to see if they behave as predicted.

"The 1D system is a paradigm for strongly correlated electron physics, which plays a key role in many things we'd like to better understand, like high-temperature superconductivity, heavy fermion materials and more," Hulet said.

New smart materials could open new research field: Serendipitous discovery could increase efficiency in jet engines, reduce plane noise, more -- ScienceDaily

A group of new smart materials discovered by researchers at Texas A&M University and their colleagues has the potential to significantly improve the efficiency of fuel burn in jet engines, cutting the cost of flying. The materials, which could also reduce airplane noise over residential areas, have additional applications in a variety of other industries.

"What excites me is that we have just scratched the surface of something new that could not only open a completely new field of scientific research, but also enable new technologies," said Dr. Ibrahim Karaman, Chevron Professor I and head of the university's Department of Materials Science and Engineering.

The work was published in *Scripta Materialia*. Karaman's co-authors are Demircan Canadinc, William Trehern, and Ji Ma of Texas A&M, and Fanping Sun and Zaffir Chaudhry, Technical Fellow of the United Technologies Research Center (UTRC).

The discovery is based on bringing together two relatively new areas of materials science involving metal alloys, or metals composed of two or more elements. The first area involves shape-memory alloys, "smart" materials that can switch from one shape to another with specific triggers, in this case temperature. Picture a straight metal rod that is bent into a corkscrew. By changing the temperature, the corkscrew turns back into a rod and vice versa.

Many applications

Many potential applications for shape-memory alloys involve extremely hot environments like a working jet engine. Until now, however, economical

high-temperature shape memory alloys, (HTSMAs), have only worked at temperatures up to about 400 degrees Celsius. Adding elements like gold or platinum can significantly increase that temperature, but the resulting materials are much too expensive, among other limitations.

Karaman, while working on a NASA project with UTRC and colleagues, began this research to address a specific problem: controlling the clearance, or space, between turbine blades and the turbine case in a jet engine. A jet engine is most fuel-efficient when the gap between the turbine blades and the case is minimized. However, this clearance has to have a fair margin to deal with peculiar operating conditions. HTSMAs incorporated into the turbine case could allow the maintenance of the minimum clearance across all flight regimes, thereby improving thrust specific fuel consumption.

Another important potential application of HTSMAs is the reduction of noise from airplanes as they come in to an airport. Planes with larger exhaust nozzles are quieter, but less efficient in the air. HTSMAs could automatically change the size of the core exhaust nozzle depending on whether the plane is in flight or is landing. Such a change, triggered by the temperatures associated with these modes of operation, could allow both more efficient operation while in the air and quieter conditions at touchdown.

Karaman and his colleagues decided to try increasing the operating temperatures of HTSMAs by applying principles from another new class of materials, high-entropy alloys, which are composed of four or more elements mixed together in roughly equal amounts. The team created materials composed of four or more elements known to form shape-memory alloys (nickel, titanium, hafnium, zirconium and palladium), but purposefully omitted gold or platinum.

"When we mixed these elements in equal proportions we found that the resulting materials could work at temperatures well over 500 degrees C -- one worked at 700 degrees C -- without gold or platinum. That's a discovery," said Karaman. "It was also unexpected because the literature suggested otherwise."

How do the new materials work? Karaman said they have ideas on how they operate at such high temperatures, but do not have solid theories yet. To that

end, future work includes trying to understand what is happening at the atomic scale by conducting computer simulations. The researchers also aim to explore ways to improve the materials' properties even further. Karaman notes, however, that many other questions remain.

"That's why I believe this could open a completely new area of research," he said. "While we will continue our own efforts, we are excited that others will now join us so that together we can push the boundaries of science."

This joint project between UTRC and Texas A&M was funded by the NASA Leading Edge Aeronautics Research initiative.

Story Source:

Materials provided by **Texas A&M University**. Original written by Elizabeth Thomson. *Note: Content may be edited for style and length.*

State-of-the-art imaging techniques reveal heightened detail and beauty of vertebrate life -- ScienceDaily

A mingling of science and art, the next-generation photographs of vertebrate skeletons are at once fascinating, eerie, intricate and exquisite.

"People are inherently interested in how these skeletons look," said W. Leo Smith, associate professor of ecology and evolutionary biology and associate curator at the University of Kansas Biodiversity Institute & Natural History Museum. "In any given scholarly paper, you'd be lucky to have a couple of hundred people read it top to bottom -- but a lot more people will look at the images. The more we can improve that, the more people you can get interested in your research."

Since the 1800s, biologists and paleontologists have taken pictures of specimens to perform comparative anatomical studies. Now, techniques pioneered by Smith and a team of researchers headquartered at KU are giving scientists around the world fresh methods to capture images of vertebrates -- a breakthrough enabling better, more useful digital pictures of Earth's biodiversity.

The team describes the two novel imaging procedures in a new paper appearing in the peer-reviewed journal *Copeia*.

One new process involves "cleared and stained" specimens, which have been stripped of their muscles in a time-honored technique using cow enzymes. The team discovered how to position such specimens within a glycerine-gelatin mixture for otherwise impossible images.

"The problem we had was we couldn't pose these animals because we've digested away all of the muscles," Smith said. "They're flaccid and useless, like a pile of clothes that fold in every direction. We wanted the ability to

pose them."

The researchers hunted for the best ratio of glycerine and gelatin that allowed specimens to be posed in a nondestructive medium that could be simply washed off after photography. Much of the "nitty gritty" work was performed by doctoral student Matthew Girard and intern Chesney A. Buck, an aspiring taxidermist interning with Smith's group from Van Go Inc., an arts-based employment program for at-risk teens and young adults.

"She was interested in artistic taxidermy, mixing animal parts like have been done with the jackalope," Smith said. "She knew about clearing and staining and wanted to know how to do it. After her internship, she volunteered for a year more. There was a lot of trial and error. We tried lots of different things."

Other co-authors on the new paper are Gregory S. Ornay, Rene P. Martin and Girard of KU's Biodiversity Institute, along with Matthew P. Davis and Sarah Z. Gibson of St. Cloud State University.

Eventually, the team found a 40 percent glycerine mixture that held specimens well and was sufficiently translucent for photography, allowing them new looks at specimens that could "float" within the matrix.

"You can see through this medium and give the specimen structure," Smith said. "Now you can get a photo of a fish specimen head on and look at it from all these different angles. There's something different about being able to see anatomical structure in new ways that really does help analysis. Before, we struggled with how to pose these things. For instance, fish are famous for having two sets of jaws, an oral set like ours and then another set of teeth where our voice box is -- you couldn't get a photo of these teeth head-on before now."

Smith said the new technique could be used on a host of vertebrate species beyond the fishes he studies.

"It'd be great to pose a snake coiled, but before now they just wouldn't hold in that pose. Or if you were trying to get an image of some structure obscured by the wing of a bird and couldn't get it out of the way, we've often had to cut

the wing off, but now you could deflect the wing to show that structure."

A second method developed by the group employs fluorescent microscopy to examine specimens and create captivating images of alizarin-stained recent and fossil vertebrates. The work hinges on the fact that alizarin, a stain long used in the clearing and staining process to identify bones in a specimen, fluoresces when exposed to the right wavelengths of light -- a phenomenon Smith discovered himself. (Another team independently discovered the phenomenon in a paper about zebrafish.)

"Alizarin red is used to dye a specimen's bones, and it fluoresces like a Grateful Dead poster," Smith said. "We use lights that have high energy and look for reflections of re-emitted fluorescent wavelength, and the microscope has filters that block all the other light. The skin and everything else disappears because it doesn't fluoresce -- it's a fast way to clear out all the extra stuff and is incredibly useful when you're trying to see where bones are connected. It was pure luck to find this."

The KU researcher reported the fluorescence microscopy finding to colleagues last year at the annual meeting of the American Society of Ichthyologists and Herpetologists, and today other investigators in the field already are using the matrix in their own digital imaging work thanks to the presentation.

"Now lots of people are doing it," Smith said. "It's been really rewarding. You feel like you contributed something to make this kind of research more interesting and allow us to study anatomy better."

While Smith doesn't consider the how-to descriptions of new imaging techniques to be of equal weight as the scientific papers he regularly produces, he stressed the importance of providing compelling images to conveying information to fellow investigators and the public alike.

"At end of the day, the picture is worth a thousand words," he said. "Images allow you to fundamentally share how things work and improve your ability to tell someone else about your novel discoveries."

https://www.sciencedaily.com/releases/2018/09/180904140605.htm

Peering into private life of atomic clusters -- using the world's tiniest test tubes -- ScienceDaily

Experts in the Nanoscale and Microscale Research Centre (nmRC) at the University of Nottingham have taken a first peak into the private life of atomic clusters. Here's what they can see.

Having already succeeded in 'filming' inter-molecular chemical reactions -- using the electron beam of a transmission electron microscope (TEM) as a stop-frame imaging tool -- they have now achieved time-resolved imaging of atomic-scale dynamics and chemical transformations promoted by metal nanoclusters. This has enabled them to rank 14 different metals both in order of their bonding with carbon and their catalytic activity, showing significant variation across the Periodic Table of Elements.

Their latest work, 'Comparison of atomic scale dynamics for the middle and late transition metal nanocatalysts', has been published in *Nature Communications*. Andrei Khlobystov, Professor of Nanomaterials and Director of nmRC, said: "Thanks to the recent advances in microscopy and spectroscopy we now know a great deal about the behaviour of molecules and atoms. However, the structure and dynamics of atomic-scale clusters of metallic elements remains a mystery. The complex atomic dynamics revealed directly by imaging in real time sheds light on atomistic workings of nanocatalysts."

Contribution to global GDP

The atomic-scale dynamics of metal nanoclusters determine their functional and chemical properties such as catalytic activity -- their ability to increase the rate of a chemical reaction. Many key industrial processes currently rely on nanocatalysts such as water purification; fuel cell technologies; energy storage; and bio-diesel production.

Professor Khlobystov said: "With catalytic chemical reactions contributing substantially to the global GDP, understanding the dynamic behaviour of nanoclusters at the atomic level is an important and urgent task. However, the combined challenge of non-uniform structures of nanocatalysts -- for example, distribution of sizes, shapes, crystal phases -- coexisting within the same material and their highly dynamic nature -- nanoclusters undergo extensive structural and, in some cases, chemical transformations during catalysis -- makes elucidation of the atomistic mechanisms of their behaviour virtually impossible."

From single-molecule dynamics to atomic clusters

Professor Khlobystov led the Anglo-German collaboration that harnessed the impact of the electron beam (e-beam) in the transmission electron microscopy (TEM) for imaging single-molecule dynamics. By employing the e-beam simultaneously as an imaging tool and a source of energy to drive chemical reactions they succeeded at filming reactions of molecules. The research was published last year in ACS Nano, a flagship nanoscience and nanotechnology journal, and selected as ACS Editor's Choice due to its potential for broad public interest.

Instead of laboratory flasks or test tubes, they employ the World's tiniest test tubes -- single walled carbon nanotubes -- atomically thin cylinders of carbon with internal diameters of 1-2 nm that have held a Guinness World Record since 2005.

A Periodic Table in a nano test tube

Professor Khlobystov said: "We use these carbon nanotubes to sample tiny clusters of chemical elements, each consisting of only a few dozens of atoms. By entrapping the nanoclusters of a series of related metallic elements we effectively created in a Periodic Table in a nano test tube, allowing a global comparison of chemistry of transition metals across the Periodic Table. This has always been extremely challenging because most metal nanoclusters are highly sensitive to air. The combination of the nano test tube and TEM allows us to watch not only the dynamics of metal nanoclusters but also their bonding with carbon that show a clear link with the metal's position in the Periodic Table."

Ute Kaiser, Professor in Experimental Physics and Leader of the Group of Electron Microscopy of Materials Science at Ulm University said: "Aberration-corrected transmission electron microscopy and the low-dimensional materials, such as nanotubes filled with metal nanoclusters, are an ideal match for each other because they allow an effective combination of advances in analytical and theoretical chemistry with latest developments in electron microscopy, leading to new understanding of phenomena at the atomic scale, such as nanocatalysis in this work."

Watching nanoclusters in unprecedented resolution

Kecheng Cao, PhD student at Ulm University, who carried out image analysis in this study said: "When I am looking at atoms through the microscope, sometimes I stop breathing to see the invisible details we discover for the nanoclusters on our newly developed SALVE III microscope providing unprecedented resolution."

Elena Besley, Professor of Theoretical and Computational Chemistry at the University of Nottingham said: "Reaching inside the tiniest building blocks of metals, this study demonstrated that metal nanoclusters entrapped in carbon nano test tubes provide a universal platform for studying organometallic chemistry and enable a direct comparison of the bonding and reactivity of different transition metals as well as elucidation of the structure-performance relationship for nanocatalysts -- vital for the discovery of new reaction mechanisms and more efficient catalysts of the future. This study provides a first qualitative glimpse of a global perspective of metal-carbon bonding."

This study is the latest in a series of more than 20 high-calibre joint papers on the topic of electron microscopy for molecules and nanomaterials published by the Ulm-Nottingham collaboration.

Professor Kaiser has recently been appointed an Honorary Professor at the University of Nottingham in recognition of her rich contribution to the collaboration between the two universities spanning over nearly a decade.

Measuring the nanoworld -- ScienceDaily

A worldwide study involving 20 laboratories has established and standardized a method to measure exact distances within individual biomolecules, down to the scale of one millionth of the width of a human hair. The new method represents a major improvement of a technology called single-molecule FRET (Förster Resonance Energy Transfer), in which the movement and interaction of fluorescently labelled molecules can be monitored in real time even in living cells. So far, the technology has mainly been used to report changes in relative distances -- for instance, whether the molecules moved closer together or farther apart.

Prof. Dr. Thorsten Hugel of the Institute of Physical Chemistry and the BIOSS Centre for Biological Signalling Studies is one of the lead scientists of the study, which was recently published in *Nature Methods*.

FRET works similarly to proximity sensors in cars: the closer the object is, the louder or more frequent the beeps become. Instead of relying on acoustics, FRET is based on proximity-dependent changes in the fluorescent light emitted from two dyes and is detected by sensitive microscopes. The technology has revolutionised the analysis of the movement and interactions of biomolecules in living cells.

Hugel and colleagues envisioned that once a FRET standard had been established, unknown distances could be determined with high confidence. By working together, the 20 laboratories involved in the study refined the method in such a way that scientists using different microscopes and analysis software obtained the same distances, even in the sub-nanometer range.

"The absolute distance information that can be acquired with this method now enables us to accurately assign conformations in dynamic biomolecules, or even to determine their structures," says Thorsten Hugel, who headed the study together with Dr. Tim Craggs (University of Sheffield/Great-Britain), Prof. Dr. Claus Seidel (University of Düsseldorf) and Prof. Dr. Jens Michaelis (University of Ulm). Such dynamic structural information will

yield a better understanding of the molecular machines and processes that are the basis of life.

Story Source:

Materials provided by **University of Freiburg**. *Note: Content may be edited for style and length.*

New technology improves hydrogen manufacturing -- ScienceDaily

Industrial hydrogen is closer to being produced more efficiently, thanks to findings outlined in a new paper published by Idaho National Laboratory researchers. In the paper, Dr. Dong Ding and his colleagues detailed advances in the production of hydrogen, which is used in oil refining, petrochemical manufacturing and as an eco-friendly fuel for transportation.

The researchers demonstrated high-performance electrochemical hydrogen production at a lower temperature than had been possible before. This was due to a key advance: a ceramic steam electrode that self-assembles from a woven mat.

"We invented a 3D self-assembled steam electrode which can be scalable," said Ding. "The ultrahigh porosity and the 3D structure can make the mass/charge transfer much better, so the performance was better."

In a paper published by the journal *Advanced Science*, the researchers reported on the design, fabrication and characterization of highly efficient proton-conducting solid oxide electrolysis cells (P-SOECs) with a novel 3D self-assembled steam electrode. The cells operated below 600o C. They produced hydrogen at a high sustained rate continuously for days during testing.

Hydrogen is an eco-friendly fuel in part because when it burns, the result is water. However, there are no convenient suitable natural sources for pure hydrogen. Today, hydrogen is obtained by steam reforming (or "cracking") hydrocarbons, such as natural gas. This process, though, requires fossil fuels and creates carbon byproducts, which makes it less suited for sustainable production.

Steam electrolysis, by contrast, needs only water and electricity to split water molecules, thereby generating hydrogen and oxygen. The electricity can

come from any source, including wind, solar, nuclear and other emission-free sources. Being able to do electrolysis efficiently at as low a temperature as possible minimizes the energy needed.

A P-SOEC has a porous steam electrode, a hydrogen electrode and a proton-conducting electrolyte. When voltage is applied, steam travels through the porous steam electrode and turns into oxygen and hydrogen at the electrolyte boundary. Due to differing charges, the two gases separate and are collected at their respective electrodes.

So, the construction of the porous steam electrode is critical, which is why the researchers used an innovative way to make it. They started with a woven textile template, put it into a precursor solution containing elements they wanted to use, and then fired it to remove the fabric and leave behind the ceramic. The result was a ceramic version of the original textile.

They put the ceramic textile in the electrode and noticed that in operation, bridging occurred between strands. This should improve both mass and charge transfer and the stability of the electrode, according to Dr. Wei Wu, the primary contributor to this work.

The electrode and the use of proton conduction enabled high hydrogen production below 600o C. That is cooler by hundreds of degrees than is the case with conventional high-temperature steam electrolysis methods. The lower temperature makes the hydrogen production process more durable, and also requires fewer costly, heat-resistant materials in the electrolysis cell.

Although hydrogen is already used to power vehicles, for energy storage and as portable energy, this approach could offer a more efficient alternative for high-volume production.

Story Source:

Materials provided by **DOE/Idaho National Laboratory**. *Note: Content may be edited for style and length.*

AI beats doctors at predicting heart disease deaths -- ScienceDaily

A model developed using artificial intelligence (AI) is better at predicting risk of death in patients with heart disease than models designed by medical experts, a new study from the Francis Crick Institute shows.

The study, published in *PLOS One*, adds to the growing evidence that AI could revolutionise healthcare in the UK and beyond. So far, the emphasis has been on the potential of AI to help diagnose and treat various diseases, but these new findings suggest it could also help predict the likelihood of patients dying too.

"It won't be long before doctors are routinely using these sorts of tools in the clinic to make better diagnoses and prognoses, which can help them decide the best ways to care for their patients," says Crick scientist Andrew Steele, first author of the paper.

"Doctors already use computer-based tools to work out whether a patient is at risk of heart disease, and machine-learning will allow more accurate models to be developed for a wider range of conditions."

Data-driven model

The model was designed using the electronic health data of over 80,000 patients, collected as part of routine care, and available for researchers on the CALIBER platform.

Scientists at the Crick, working collaboratively with colleagues at the Farr Institute of Health Informatics Research and University College London Hospitals NHS Foundation Trust, wanted to see if they could create a model for coronary artery disease -- the leading cause of death in the UK -- that outperforms experts using self-taught machine learning techniques.

Coronary artery disease develops when the major blood vessels that supply the heart with blood, oxygen and nutrients become damaged, or narrowed by fatty deposits. Eventually restricted blood flow to the heart can lead to chest pain and shortness of breath, while a complete blockage can cause a heart attack.

An expert-constructed prognostic model for coronary artery disease which this work was compared against made predictions based on 27 variables chosen by medical experts, such as age, gender and chest pains. By contrast, the Crick team got their AI algorithms to train themselves, searching for patterns and picking the most relevant variables from a set of 600.

Outperforming experts

Not only did the new data-driven model beat expert-designed models at predicting patient mortality, but it also identified new variables that doctors hadn't thought of.

"Along with factors like age and whether or not a patient smoked, our models pulled out a home visit from their GP as a good predictor of patient mortality," says Andrew. "Home visits are not something a cardiologist might say is important in the biology of heart disease, but perhaps a good indication that the patient is too unwell to make it to the doctor themselves, and a useful variable to help the model make accurate predictions."

This study was a proof-of-principle to compare expert-designed models to machine learning approaches, but a similar model could be implemented in the clinic in the not too distant future.

"Machine learning is hugely powerful tool in medicine and has the ability to revolutionise how we deliver care to patients over the next few years," says Andrew.

Story Source:

Materials provided by **The Francis Crick Institute**. *Note: Content may be edited for style and length.*

A quantum gate between atoms and photons may help in scaling up quantum computers -- ScienceDaily

The quantum computers of the future will be able to perform computations that cannot be done on today's computers. These may likely include the ability to crack the encryption that is currently used for secure electronic transactions, as well as the means to efficiently solve unwieldy problems in which the number of possible solutions increases exponentially. Research in the quantum optics lab of Prof. Barak Dayan in the Weizmann Institute of Science may be bringing the development of such computers one step closer by providing the "quantum gates" that are required for communication within and between such quantum computers.

In contrast with today's electronic bits that can only exist in one of two states -- zero or one -- quantum bits known as qubits can also be in states that correspond to both zero and one at the same time. This is called quantum superposition, and it gives qubits an edge as a computer made of them could perform numerous computations in parallel.

There is just one catch: The state of quantum superposition state can exist only as long as it is not observed or measured in any way by the outside world; otherwise all the possible states collapse into a single one. This leads to contradicting requirements: For the qubits to exist in several states at once they need to be well isolated, yet at the same time they need to interact and communicate with many other qubits. That is why, although several labs and companies around the world have already demonstrated small-scale quantum computers with a few dozen qubits, the challenge of scaling up these to the desired scale of millions of qubits remains a major scientific and technological hurdle.

One promising solution is using isolated modules with small, manageable numbers of qubits, which can communicate between them when needed with

optical links. The information stored in a material qubit (e.g. a single atom or ion) would then be transferred to a "flying qubit" -- a single particle of light called a photon. This photon can be sent through optical fibers to a distant material qubit and transfer its information without letting the environment sense the nature of that information. The challenge in creating such a system is that single photons carry extremely small amounts of energy, and the minuscule systems comprising material qubits generally do not interact strongly with such weak light.

Dayan's quantum optics lab in the Weizmann Institute of Science is one of the few groups worldwide that are focused entirely on attacking this scientific challenge. Their experimental setup has single atoms coupled to unique micron-scale silica resonators on chips; and photons are sent directly to these through special optical fibers. In previous experiments Dayan and his group had demonstrated the ability of their system to function as a single-photon activated switch, and also a way to "pluck" a single photon from a flash of light. In the present study, reported in *Nature Physics*, Dayan and his team succeeded -- for the first time -- to create a logic gate in which a photon and an atom automatically exchange the information they carry.

"The photon carries one qubit, and the atom is a second qubit," says Dayan. "Each time the photon and the atom meet they exchange the qubits between them automatically and simultaneously, and the photon then continues on its way with the new bit of information. In quantum mechanics, in which information cannot be copied or erased, this swapping of information is in fact the basic unit of reading and writing -- the "native" gate of quantum communication."

This type of logic gate -- a SWAP gate -- can be used to exchange qubits both within and between quantum computers. As this gate needs no external control fields or management system, it can enable the construction of the quantum equivalent of very large-scale integration (VLSI) networks. "The SWAP gate we demonstrated is applicable to photonic communication between all types of matter-based qubits -- not only atoms," says Dayan. "We therefore believe that it will become an essential building-block in the next generation of quantum computing systems."

Story Source:

Boosting gravitational wave detectors with quantum tricks -- ScienceDaily

A group of scientists from the Niels Bohr Institute (NBI) at the University of Copenhagen will soon start developing a new line of technical equipment in order to dramatically improve gravitational wave detectors.

Gravitational wave detectors are extremely sensitive and can e.g. register colliding neutron stars in space. Yet even higher sensitivity is sought for in order to expand our knowledge about the Universe, and the NBI-scientists are convinced that their equipment can improve the detectors, says Professor Eugene Polzik: "And we should be able to show proof of concept within approximately three years."

If the NBI-scientists are able to improve the gravitational wave detectors as much as they "realistically expect can be done," the detectors will be able to monitor and carry out measurements in an eight times bigger volume of space than what is currently possible, explains Eugene Polzik: "This will represent a truly significant extension."

Polzik is head of Quantum Optics (Quantop) at NBI and he will spearhead the development of the tailor made equipment for gravitational wave detectors. The research -- which is supported by the EU, the Eureka Network Projects and the US-based John Templeton Foundation with grants totaling DKK 10 million -- will be carried out in Eugene Polzik's lab at NBI.

A collision well noticed

News media all over the world shifted into overdrive in October of 2017 when it was confirmed that a large international team of scientists had indeed measured the collision of two neutron stars; an event which took place 140 million light years from Earth and resulted in the formation of a kilonova.

The international team of scientists -- which also included experts from NBI -

- was able to confirm the collision by measuring gravitational waves from space -- waves in the fabric of spacetime itself, moving at the speed of light. The waves were registered by three gravitational wave detectors: the two US-based LIGO-detectors and the European Virgo-detector in Italy.

"These gravitational wave detectors represent by far the most sensitive measuring equipment man has yet manufactured -- still the detectors are not as accurate as they could possibly be. And this is what we intend to improve," says Professor Eugene Polzik.

How this can be done is outlined in an article which Eugene Polzik and a colleague, Farid Khalili from LIGO collaboration and Moscow State University, have recently published in the scientific journal *Physical Review Letters*. And this is not merely a theoretical proposal, says Eugene Polzik:

"We are convinced this will work as intended. Our calculations show that we ought to be able to improve the precision of measurements carried out by the gravitational wave detectors by a factor of two. And if we succeed, this will result in an increase by a factor of eight of the volume in space which gravitational wave detectors are able to examine at present."

A small glass cell

In July of last year Eugene Polzik and his team at Quantop published a highly noticed article in *Nature* -- and this work is actually the very foundation of their upcoming attempt to improve the gravitational wave detectors.

The article in *Nature* centered on 'fooling' Heisenberg's Uncertainty Principle, which basically says that you cannot simultaneously know the exact position and the exact speed of an object.

This has to do with the fact that observations conducted by shining light on an object inevitably will lead to the object being 'kicked' in random directions by photons, particles of light. This phenomenon is known as Quantum Back Action (QBA) and these random movements put a limit to the accuracy with which measurements can be carried out at the quantum level.

The article in *Nature* in the summer of 2017 made headlines because Eugene

Polzik and his team were able to show that it is -- to a large extent -- actually possible to neutralize QBA.

And QBA is the very reason why gravitational wave detectors -- that also operate with light, namely laser light -- "are not as accurate as they could possibly be," as professor Polzik says.

Put simply, it is possible to neutralize QBA if the light used to observe an object is initially sent through a 'filter'. This was what the article in Nature described -- and the 'filter' which the NBI-scientists at Quantop had developed and described consisted of a cloud of 100 million caesium atoms locked-up in a hermetically closed glass cell just one centimeter long, 1/3 of a millimeter high and 1/3 of a millimeter wide.

The principle behind this 'filter' is exactly what Polzik and his team are aiming to incorporate in gravitational wave detectors.

In theory one can optimize measurements of gravitational waves by switching to stronger laser light than the detectors in both Europe and USA are operating with. However, according to quantum mechanics, that is not an option, says Eugene Polzik:

"Switching to stronger laser light will just make a set of mirrors in the detectors shake more because Quantum Back Action will be caused by more photons. These mirrors are absolutely crucial, and if they start shaking, it will in fact increase inaccuracy."

Instead, the NBI-scientists have come up with a plan based on the atomic 'filter' which they demonstrated in the Nature article: They will send the laser light by which the gravitational wave detectors operate through a tailor made version of the cell with the locked-up atoms, says Eugene Polzik: "And we hope that it will do the job."

Quantum weirdness in 'chicken or egg' paradox -- ScienceDaily

The "chicken or egg" paradox was first proposed by philosophers in Ancient Greece to describe the problem of determining cause-and-effect.

Now, a team of physicists from The University of Queensland and the NÉEL Institute has shown that, as far as quantum physics is concerned, the chicken and the egg can both come first.

Dr Jacqui Romero from the ARC Centre of Excellence for Engineered Quantum Systems said that in quantum physics, cause-and-effect is not always as straightforward as one event causing another.

"The weirdness of quantum mechanics means that events can happen without a set order," she said.

"Take the example of your daily trip to work, where you travel partly by bus and partly by train.

"Normally, you would take the bus then the train, or the other way round.

"In our experiment, both of these events can happen first," Dr Romero said.

"This is called `indefinite causal order' and it isn't something that we can observe in our everyday life."

To observe this effect in the lab, the researchers used a setup called a photonic quantum switch.

UQ's Dr Fabio Costa said that with this device the order of events -- transformations on the shape of light -- depends on polarisation.

"By measuring the polarisation of the photons at the output of the quantum switch, we were able to show the order of transformations on the shape of

light was not set."

"This is just a first proof of principle, but on a larger scale indefinite causal order can have real practical applications, like making computers more efficient or improving communication."

The research was published in *Physical Reviews Letters* by the American Physical Society.

Story Source:

Materials provided by **University of Queensland**. *Note: Content may be edited for style and length.*

Telescope maps cosmic rays in Large and Small Magellanic Clouds -- ScienceDaily

A radio telescope in outback Western Australia has been used to observe radiation from cosmic rays in two neighbouring galaxies, showing areas of star formation and echoes of past supernovae.

The Murchison Widefield Array (MWA) telescope was able to map the Large Magellanic Cloud and Small Magellanic Cloud galaxies in unprecedented detail as they orbit around the Milky Way.

By observing the sky at very low frequencies, astronomers detected cosmic rays and hot gas in the two galaxies and identified patches where new stars are born and remnants from stellar explosions can be found.

The research was published today in *Monthly Notices of the Royal Astronomical Society*, one of the world's leading astronomy journals.

International Centre for Radio Astronomy Research (ICRAR) astrophysicist Professor Lister Staveley-Smith said cosmic rays are very energetic charged particles that interact with magnetic fields to create radiation we can see with radio telescopes.

"These cosmic rays actually originate in supernova remnants -- remnants from stars that exploded a long time ago," he said.

"The supernova explosions they come from are related to very massive stars, much more massive than our own Sun.

"The number of cosmic rays that are produced depends on the rate of formation of these massive stars millions of years ago."

The Large and Small Magellanic Clouds are very close to our own Milky Way -- less than 200,000 light years away -- and can be seen in the night sky

with the naked eye.

ICRAR astronomer Dr Bi-Qing For, who led the research, said this was the first time the galaxies had been mapped in detail at such low radio frequencies.

"Observing the Magellanic Clouds at these very low frequencies -- between 76 and 227MHz -- meant we could estimate the number of new stars being formed in these galaxies," she said.

"We found that the rate of star formation in the Large Magellanic Cloud is roughly equivalent to one new star the mass of our Sun being produced every ten years.

"In the Small Magellanic Cloud, the rate of star formation is roughly equivalent to one new star the mass of our Sun every forty years."

Included in the observations are 30 Doradus, an exceptional region of star formation in the Large Magellanic Cloud that is brighter than any star formation region in the Milky Way, and Supernova 1987A, the brightest supernova since the invention of the telescope.

Professor Staveley-Smith said the results are an exciting glimpse into the science that will be possible with next-generation radio telescopes.

"It shows an indication of the results that we will see with the upgraded MWA, which now has twice the previous resolution," he said.

Furthermore, the forthcoming Square Kilometre Array (SKA) will deliver exceptionally fine images.

"With the SKA the baselines are eight times longer again, so we'll be able to do so much better," Professor Staveley-Smith said.

Simulations reveal role of calcium in titanium implant acceptance -- ScienceDaily

Titanium-based materials are widely used in medical implant technology. Coating the surface of titanium materials with biologically active molecules has recently shown promise to improve how cells adhere to implants and promote tissue regeneration. The mechanisms behind how peptides stick to titanium, however, are not fully understood.

Researchers at Deakin University in Australia found how calcium ions present at the interface between titanium oxide and tissues affect how well peptides bind to the metal. The team reports their findings in a special issue of *Biointerphases*, from AIP Publishing, that is highlighting women in the field of biointerface science. Using recently developed tools in molecular dynamics simulations, the group's findings provide an early understanding in how one day we might use salt's composition to finely tune the reactions between titanium implants and the body.

"This work contributes to a long-running and ongoing effort to identify systematic improvements for load-bearing implant materials," said Tiffany Walsh, an author on the paper. "The binding behaviors we have identified for these peptides in the presence of ions might guide others in the design of new implant coatings."

It is believed that coating titanium surfaces with biomolecules to adhere to host tissues is aided by nearby inorganic ions in the body. Because of their higher positive charge and role in cell signaling, calcium ions are suspected to be particularly helpful.

To tackle these questions, Walsh and her colleagues created a computer model of the oxidized surface of titanium. The group simulated two titanium-binding peptides, Ti-1 and Ti-2, in solutions of calcium chloride and sodium chloride using molecular dynamics simulations. This computation approach approximates and models the interactions between the numerous molecules in

a system. In their model, they relied on an advanced technique called replica exchange with solute tempering that accelerates the exploration of the peptide structures.

The group discovered that positively charged calcium ions helped Ti-1 adhere to the titanium surface by acting as a connector between the negatively charged titanium oxide and asparagine, a residue within the Ti-1 peptide. This process then leads to other residues pinning directly to the titanium oxide surface. For Ti-2, however, calcium ions were found to limit access to the surface.

The data from their simulations point to improved principles for designing peptides with tunable affinity to titanium application. Walsh said she expects that their findings will lead to exploring the titanium-tissue interface further, including molecules with one binding domain for titanium and one for biomolecules.

"Titanium is a common implant material, and our comprehension of how to beneficially modulate the interaction between titanium and living tissue, while very advanced, still has a lot to go," Walsh said. "We want to contribute to this ongoing effort."

Story Source:

Materials provided by **American Institute of Physics**. *Note: Content may be edited for style and length.*

Veiled supernovae provide clue to stellar evolution -- ScienceDaily

At the end of its life, a red supergiant star explodes in a hydrogen-rich supernova. By comparing observation results to simulation models, an international research team found that in many cases this explosion takes place inside a thick cloud of circumstellar matter shrouding the star. This result completely changes our understanding of the last stage of stellar evolution.

The research team led by Francisco Förster at the University of Chile used the Blanco Telescope to find 26 supernovae coming from red supergiants. Their goal was to study the shock breakout, a brief flash of light preceding the main supernova explosion. But they could not find any signs of this phenomenon. On the other hand, 24 of the supernovae brightened faster than expected.

To solve this mystery, Takashi Moriya at the National Astronomical Observatory of Japan (NAOJ) simulated 518 models of supernovae brightness variations and compared them with the observational results. The team found that models with a layer of circumstellar matter about 10 percent the mass of the Sun surrounding the supernovae matched the observations well. This circumstellar matter hides the shock breakout, trapping its light. The subsequent collision between the supernova ejecta and the circumstellar matter creates a strong shock wave that produces extra light, causing it to brighten more quickly.

Moriya explains, "Near the end of its life, some mechanism in the star's interior must cause it to shed mass that then forms a layer around the star. We don't yet have a clear idea of the mechanism causing this mass loss. Further study is needed to get a better understanding of the mass loss mechanism. This will also be important in revealing the supernova explosion mechanism and the origin of the diversity in supernovae."

These observations were performed by the Blanco Telescope at Cerro Tololo Inter-American Observatory during six nights in 2014 and eight nights in 2015. The simulations by Moriya were performed on the NAOJ Center for Computational Astrophysics PC cluster. This research was published in Nature Astronomy on September 3, 2018.

Story Source:

Materials provided by **National Institutes of Natural Sciences**. *Note: Content may be edited for style and length.*

Satellites more at risk from fast solar wind than a major space storm -- ScienceDaily

Satellites are more likely to be at risk from high-speed solar wind than a major geomagnetic storm according to a new UK-US study published this week in the Journal *Space Weather*.

Researchers investigating the space weather risks to orbiting satellites calculated electron radiation levels within the Van Allen radiation belts. This ring-doughnut-shaped zone wraps around the Earth, trapping charged particles. Geostationary orbit lies inside the Van Allen radiation belts

The study, which analysed years of satellite data, found that electron radiation levels at geostationary orbit could remain exceptionally high for 5 days or more, even after the solar wind speed had died down. As a result, electronic components on satellites could charge up to dangerously high levels and become damaged.

Professor Richard Horne, lead author of the study, said:

"Until now we thought that the biggest risk to orbiting satellites was geomagnetic storms. Our study constructed a realistic worst-case event by looking at space weather events caused by high-speed solar wind flowing away from the Sun and striking the Earth. We were surprised to discover just how high electron radiation levels can go."

This new research is particularly interesting to the satellite industry. Professor Horne continues:

"Fast solar wind is more dangerous to satellites because the geomagnetic field extends beyond geostationary orbit and electron radiation levels are increased all the way round the orbit -- in a major geomagnetic storm the field is distorted and radiation levels peak closer to the Earth.

"Electronic components on satellites are usually protected from electrostatic charges by encasing them in metal shielding. You would have to use about 2.5 mm of aluminium to reduce charging to safe levels -- much more than is used at present. There are well over 450 satellites in geostationary orbit and so in a realistic worst case we would expect many satellites to report malfunctions and a strong likelihood of service outage and total satellite loss."

Dr Nigel Meredith, a co-author on the study, said:

"A few years ago, we calculated electron radiation levels for a 1 in 150 year space weather event using statistical methods. This study uses a totally different approach but gets a very similar result and confirms that the risk of damage is real."

The solar wind is a stream of particles and magnetic field flowing away from the Sun. It flows around the Earth's magnetic field and excites so-called 'chorus' plasma waves near geostationary orbit. Chorus waves accelerate electrons and form the Van Allen radiation belts. The chorus waves also travel along the geomagnetic field to the Polar Regions where they are detected on the ground at Halley Research Station, Antarctica.

Story Source:

Materials provided by **British Antarctic Survey**. *Note: Content may be edited for style and length.*

Superradiance: Quantum effect detected in tiny diamonds -- ScienceDaily

The effect has been predicted theoretically decades ago -- but it is very hard to provide experimental evidence for it: "Superradiance" is the phenomenon of one atom giving off energy in the form of light and causing a large number of other atoms in its immediate vicinity to emit energy as well at the same time. This creates a short, intense flash of light.

Up until now, this phenomenon could only be studied with free atoms (and with the use of special symmetries). Now, at TU Wien (Vienna), it was measured in a solid-state system. The team used nitrogen atoms, built into tiny diamonds that can be coupled with microwave radiation. The results have now been published in the journal *Nature Physics*.

A bright flash of quantum light

According to the laws of quantum physics, atoms can be in different states. "When the atom absorbs energy, it is shifted into a so-called excited state. When it returns to a lower energy state, the energy is released again in the form of a photon. This usually happens randomly, at completely unpredictable points in time," says Johannes Majer, research group leader at the Institute of Atomic and Subatomic Physics (TU Wien). However, if several atoms are located close to each other, an interesting quantum effect can occur: one of the atoms emits a photon (spontaneously and randomly), thereby affecting all other excited atoms in its neighborhood. Many of them release their excess energy at the same moment, producing an intense flash of quantum light. This phenomenon is called "superradiance."

"Unfortunately, this effect cannot be directly observed with ordinary atoms," says Andreas Angerer, first author of the study. "Super radiance is only possible if you place all the atoms in an area that is significantly smaller than the wavelength of the photons." So you would have to focus the atoms to less than 100 nanometers -- and then, the interactions between the atoms would be

so strong that the effect would no longer be possible.

Defects in the diamond lattice

One solution to this problem is using a quantum system that Majer and his team have been researching for years: tiny defects built into diamonds. While ordinary diamonds consist of a regular grid of carbon atoms, lattice defects have been deliberately incorporated into the diamonds in Majer's lab. At certain points, instead of a carbon atom, there is a nitrogen atom, and the adjacent point in the diamond lattice is unoccupied.

These special diamonds with lattice defects were made in Japan by Junichi Isoya and his team at the University of Tsukuba. They have succeeded in producing the world's highest concentration of these desired defects without causing any other damage. The theoretical basis of the effect was developed by Kae Nemoto (National Institute of Informatics) and William Munro (NTT Basic Research Laboratories) in Tokyo, Japan.

Just like ordinary atoms, these diamond defects can also be switched into an excited state -- but this is achieved with photons in the microwave range, with a very large wavelength. "Our system has the decisive advantage that we can work with electromagnetic radiation that has a wavelength of several centimeters -- so it is no problem to concentrate the individual defect sites within the radius of one wavelength," explains Andreas Angerer.

When many diamond defects are switched to an excited state, it can usually take hours for all of them to return to the lower-energy state. Due to the superradiance effect, however, this happens within about 100 nanoseconds. The first photon that is sent out spontaneously causes all other defect sites to emit photons as well.

Similar to lasers

Superradiance is based on the same basic principle as the laser -- in both cases there is a stimulated emission of photons, triggered by a photon hitting energetically excited atoms. Nevertheless, these are two quite different phenomena: In the laser, a permanent background of many photons is needed, constantly stimulating new atoms. In superradiance, a single photon triggers a

flash of light all by itself.

"In a sense, superradiance is the more interesting effect, from a quantum physics point of view," says Johannes Majer. "Today, many novel quantum effects are studied, in which the entanglement of many particles plays an important role. Superradiance is one of them. I expect that this will lead to something new, which we might call Quantum Technology 2.0 in the next few decades."

Cathode fabrication for oxide solid-state batteries at room temperature: Thick-film cathode solidified on garnet-type oxide solid electrolyte at room temperature -- ScienceDaily

Researchers at the Toyohashi University of Technology have successfully fabricated a lithium trivanadate (LVO) cathode thick film on a garnet-type oxide solid electrolyte using the aerosol deposition method. The LVO cathode thick-film fabricated on the solid electrolyte showed a large reversible charge and discharge capacity as high as 300 mAh/g and a good cycling stability at 100 ºC. This finding may contribute to the realization of highly safe and chemically stable oxide-based all-solid-state lithium batteries. The research results were reported in *Materials* on September 1st, 2018.

Rechargeable lithium-ion batteries (LiBs) have been widely utilized globally as a power source for mobile electronic devices such as smart phones, tablets, and laptop computers because of their high-energy density and good cycling performance. Recently, the development of middle- and large-scale LiBs has been accelerated for use in automotive propulsion and stationary load-leveling for intermittent power generation from solar or wind energy. However, a larger battery size causes more serious safety issues in LIBs; one of the main reasons is the increased amount of flammable organic liquid electrolytes.

All-solid-state LiBs with nonflammable inorganic Li-ion (Li^+) conductors as solid electrolytes (SE) are expected to be the next generation of energy storage devices because of their high energy density, safety, and reliability. The SE materials must have not only high lithium-ion conductivity at room temperature, but also deformability and chemical stability. Oxide-based SE materials have a relatively low conductivity and poor deformability compared to sulfide-based ones; however, they have other advantages such as chemical

stability and ease of handling.

The garnet-type fast Li+ conducting oxide, Li7-xLa3Zr2-xTaxO12 (x = 0.4-0.5, LLZTO), is considered as a good candidate for SE because of its good ionic conducting property and high electrochemical stability. However, high-temperature sintering at 1000-1200 ºC is generally needed for densification, and this temperature is too high to suppress the undesired side reaction at the interface between SE and the majority of electrode materials. Therefore, there are currently limited electrode materials that can be used for solid-state batteries with garnet-type SEs developed by the co-sintering process.

Ryoji Inada and his colleagues at the Department of Electrical and Electronic Information Engineering, Toyohashi University of Technology, succeeded in fabricating a lithium trivanadate (LiV3O8, LVO) thick-film cathode on garnet-type LLZTO by using the aerosol deposition (AD) method. All-solid-state cell samples were prepared and tested using the fabricated composite.

The AD method is known to be a room-temperature film-fabrication process, which uses the impact-consolidation of ceramic particles onto a substrate. By controlling the particle size and morphology, dense ceramic thick films can be fabricated on various substrates without thermal treatment. This feature is attractive in the fabrication of oxide-based solid-state batteries because various electrode active materials can be selected and formed on SE with no thermal treatment.

LVO has been studied at length as a cathode material for Li-based batteries because of its large Li+ storage capacity of approximately 300 mAh/g. However, the feasibility of LVO as a cathode for solid-state batteries has not yet been investigated. The reaction of LVO initiates at the discharging (i.e., Li+ insertion) process, which differs from that of other conventional cathode materials of LiBs such as LiCoO2, LiMn2O4, and LiFePO4. Therefore, graphite anodes, which are widely used in current LiBs, are difficult to use in batteries with LVO cathodes. In solid-state batteries with garnet-type SEs, Li metal electrodes may potentially be used as anodes; thus, LVO would become an attractive candidate for high-capacity cathodes.

To fabricate a dense LVO film on an LLZTO pellet, the size of the LVO particles was controlled by ball-milling. As a result, an LVO thick film with a

thickness of 5-6 μm was successfully fabricated on LLZTO at room temperature. The relative density of the LVO thick film was approximately 85%. For the electrochemical characterization of the LVO thick film as a cathode, Li metal foil was attached on the opposite end face of the LLZTO pellet as an anode to form an LVO/LLZTO/Li structured solid-state cell. The galvanostatic charge (Li+ extraction from LVO) and discharge (Li+ insertion into LVO) properties in an LVO/LLZTO/Li all-solid-state cell were measured at 50 and 100 ºC.

Although the polarization was considerably large at 50 ºC, a reversible capacity of approximately 100 mAh/g was confirmed. With an increase in temperature to 100 ºC, the polarization reduced and the capacity increased significantly to 300 mAh/g at an averaged cell voltage of approximately 2.5 V; this is a typical behavior of an LVO electrode observed in an organic liquid electrolyte. In addition, we confirm that the charge and discharge reactions in the solid-state cell are stably cycled at various current densities. This can be attributed to the strong adhesion between the LVO film fabricated via impact consolidation and the LLZTO and LVO particles in the film.

These results indicate that LVO can potentially be used as a high-capacity cathode in an oxide-based solid-state battery with high safety and chemical stability, even though additional investigation is needed to enhance the performance. Researchers have carried out further studies to realize oxide-based solid-state batteries at lower operating temperatures.

Story Source:

Materials provided by **Toyohashi University of Technology**. *Note: Content may be edited for style and length.*

Artificial cells are tiny bacteria fighters -- ScienceDaily

"Lego block" artificial cells that can kill bacteria have been created by researchers at the University of California, Davis Department of Biomedical Engineering. The work is reported Aug. 29 in the journal *ACS Applied Materials and Interfaces*.

"We engineered artificial cells from the bottom-up -- like Lego blocks -- to destroy bacteria," said Assistant Professor Cheemeng Tan, who led the work. The cells are built from liposomes, or bubbles with a cell-like lipid membrane, and purified cellular components including proteins, DNA and metabolites.

"We demonstrated that artificial cells can sense, react and interact with bacteria, as well as function as systems that both detect and kill bacteria with little dependence on their environment," Tan said.

The team's artificial cells mimic the essential features of live cells, but are short-lived and cannot divide to reproduce themselves. The cells were designed to respond to a unique chemical signature on E. coli bacteria. They were able to detect, attack and destroy the bacteria in laboratory experiments.

Artificial cells previously only had been successful in nutrient-rich environments, Tan said. However, by optimizing the artificial cells' membranes, cytosol and genetic circuits, the team made them work in a wide variety of environments with very limited resources such as water, emphasizing their robustness in less-than-ideal or changing conditions. These improvements significantly broaden the overall potential application of artificial cells.

Antibacterial artificial cells might one day be infused into patients to tackle infections resistant to other treatments. They might also be used to deliver drugs at the specific location and time, or as biosensors.

Coauthors on the paper are Yunfeng Ding, Eliza Morris, Luis Contreras-Llano and Michelle Mao. The work was supported by NSF, a Branco-Weiss Fellowship to Tan and by a UC MEXUS-CONACYT Doctoral Fellowship to Contreras-Llano.

Story Source:

Materials provided by **University of California - Davis**. *Note: Content may be edited for style and length.*

Biophysics: Self-centered -- ScienceDaily

Essential biological processes, such as cell division, must be tightly regulated. For example, correct localization of the plane of cell division is vital for correct segregation of the duplicated genomes, and hence for the survival of both daughter cells. Bacterial cells generally divide symmetrically by forming a contractile ring, which is progressively constricted to form two daughter cells of equal size. In a new study, LMU doctoral student Silke Bergeler and her supervisor Professor Erwin Frey have developed a model that explains how the plane of division is specified in the rod-shaped bacterium *Myxococcus xanthus*. The model, which is based on experimental work done by Professor Lotte Søgaard-Andersen and her group at the Max Planck Institute for Terrestrial Microbiology in Marburg, is described in the online journal *PLoS Computational Biology*.

Prior to cell division, the bacterial genome is replicated. The region occupied by the bacterial chromosome (or 'nucleoid') is functionally equivalent to the nucleus in the cells of higher organisms. When the cell divides, the nucleoid must be centered, so that the duplicated nucleoids are equally divided between the two daughter cells. Three proteins have been identified which are required for the proper localization of the plane of cleavage at mid-cell in *M. xanthus*. Experiments by the research group in Marburg have shown that two of these, named PomX and PomY, assemble to form a large cluster, which will ultimately mark the position of mid-cell. The third, PomZ, is an ATPase -- an enzyme that binds the nucleotide ATP and can convert it into ADP. Dimer molecules made of two ATP-bound PomZ proteins can attach to the chromosomal DNA and diffuse along it, and can also bind to the PomXY cluster and diffuse at a lower rate. The action of this system ensures that the cluster is localized to the midpoint of the nucleoid, which coincides with mid-cell, where the contractile ring will form.

"We have developed a mathematical model and used it to study the detailed dynamics of the process that leads to the positioning of the cluster in the center of the nucleoid," says Bergeler. The analysis revealed that the PomZ

proteins are the crucial components in this operation. They first bind to the chromosomal DNA and subsequently recruit the cluster, thus tethering it to the nucleoid. Simultaneous binding of PomZ to the cluster and the chromosomal DNA, however, eventually activates the ATPase activity of PomZ, which causes it to detach from both the cluster and the DNA. It then diffuses in the cytosol and finally binds randomly to the nucleoid again. In addition to this delay, one other factor plays an important role in shuttling the cluster to midnucleoid: The chromosome exhibits a certain degree of elasticity, such that a specific position on the chromosome can explore the region around its equilibrium position as a result of thermal fluctuations. "Thanks to this elasticity, PomZ proteins that are bound to both the chromosome and the PomXY cluster can exert a net force on the cluster." Moreover, simulations show that the velocity of the cluster depends on the difference between the fluxes of PomZ into the cluster from either side. "The crucial point is that, if the cluster is asymmetrically placed, more PomZ proteins will be fed into it from the direction of the longer segment of the nucleoid than from the opposite side," Bergeler explains. This imbalance in the flux of PomZ serves to push the cluster toward, rather than away from, mid-cell. When the cluster's location coincides with the center of the chromosome, it remains in place because the number of PomZ molecules impinging on it from each side is essentially the same.

According to its authors, the model is also of interest in the context of other intracellular positioning systems, such as the Min system used to center the contractile ring in *E. coli*, plasmid segregation, or the mechanisms that are responsible for the localization of flagella. "By studying the similarities and differences between the various systems, one can identify the general mechanisms on which they are based," says Frey. This view is supported by the finding that the proposed mechanism can in principle lead to two distinct dynamic behaviors. If the dynamics of PomZ's movement along the nucleoid is slow relative to the diffusion of the cluster, the latter does not stably maintain its position at midnucleoid. Instead, it oscillates back and forth about the center of the nucleoid.

Story Source:

Materials provided by **Ludwig-Maximilians-Universität München**. *Note:*

Content may be edited for style and length.

Falling stars hold clue for understanding dying stars -- ScienceDaily

An international team of researchers has proposed a new method to investigate the inner workings of supernovae explosions. This new method uses meteorites and is unique in that it can determine the contribution from electron anti-neutrinos, enigmatic particles which can't be tracked through other means.

Supernovae are important events in the evolution of stars and galaxies, but the details of how the explosions occur are still unknown. This research, led by Takehito Hayakawa, a visiting professor at the National Astronomical Observatory of Japan, found a method to investigate the role of electron anti-neutrinos in supernovae. By measuring the amount of 98Ru (an isotope of Ruthenium) in meteorites, it should be possible to estimate how much of its progenitor 98Tc (a short-lived isotope of Technetium) was present in the material from which the Solar System formed. The amount of 98Tc in turn is sensitive to the characteristics, such as temperature, of electron anti-neutrinos in the supernova process; as well as to how much time passed between the supernova and the formation of the Solar System. The expected traces of 98Tc are only a little below the smallest currently detectable levels, raising hopes that they will be measured in the near future.

Hayakawa explains, "There are six neutrino species. Previous studies have shown that neutrino-isotopes are predominantly produced by the five neutrino species other than the electron anti-neutrino. By finding a neutrino-isotope synthesized predominantly by the electron anti-neutrino, we can estimate the temperatures of all six neutrino species, which are important for understanding the supernova explosion mechanism."

At the end of its life, a massive star dies in a fiery explosion known as a supernova. This explosion blasts most of the mass in the star out into outer space. That mass is then recycled into new stars and planets, leaving distinct chemical signatures which tell scientists about the supernova. Meteorites,

sometimes called falling stars, formed from material left over from the birth of the Solar System, thus preserving the original chemical signatures.

Story Source:

Materials provided by **National Institutes of Natural Sciences**. *Note: Content may be edited for style and length.*

Neutrophil nanosponges soak up proteins that promote rheumatoid arthritis -- ScienceDaily

Engineers at the University of California San Diego have developed neutrophil "nanosponges" that can safely absorb and neutralize a variety of proteins that play a role in the progression of rheumatoid arthritis. Injections of these nanosponges effectively treated severe rheumatoid arthritis in two mouse models. Administering the nanosponges early on also prevented the disease from developing.

The work is published Sept. 3 in *Nature Nanotechnology*.

"Nanosponges are a new paradigm of treatment to block pathological molecules from triggering disease in the body," said senior author Liangfang Zhang, a nanoengineering professor at the UC San Diego Jacobs School of Engineering. "Rather than creating treatments to block a few specific types of pathological molecules, we are developing a platform that can block a broad spectrum of them, and this way we can treat and prevent disease more effectively and efficiently."

This work is one of the latest examples of therapeutic nanosponges developed by Zhang's lab. Zhang, who is affiliated with the Institute of Engineering in Medicine and Moores Cancer Center at UC San Diego, and his team previously developed red blood cell nanosponges to combat and prevent MRSA infections and macrophage nanosponges to treat and manage sepsis.

The new nanosponges are nanoparticles of biodegradable polymer coated with the cell membranes of neutrophils, a type of white blood cell.

Neutrophils are among the immune system's first responders against invading pathogens. They are also known to play a role in the development of rheumatoid arthritis, a chronic autoimmune disease that causes painful

inflammation in the joints and can ultimately lead to damage of cartilage and bone tissue.

When rheumatoid arthritis develops, cells in the joints produce inflammatory proteins called cytokines. Release of cytokines signals neutrophils to enter the joints. Once there, cytokines bind to receptors on the neutrophil surfaces, activating them to release more cytokines, which in turn draws more neutrophils to the joints and so on.

The nanosponges essentially nip this inflammatory cascade in the bud. By acting as tiny neutrophil decoys, they intercept cytokines and stop them from signaling even more neutrophils to the joints, reducing inflammation and joint damage.

These nanosponges offer a promising alternative to current treatments for rheumatoid arthritis. Some monoclonal antibody drugs, for example, have helped patients manage symptoms of the disease, but they work by neutralizing only specific types of cytokines. This is not sufficient to treat the disease, said Zhang, because there are so many different types of cytokines and pathological molecules involved.

"Neutralizing just one or two types might not be as effective. So our approach is to take neutrophil cell membranes, which naturally have receptors to bind all these different types of cytokines, and use them to manage an entire population of inflammatory molecules," said Zhang.

"This strategy removes the need to identify specific cytokines or inflammatory signals in the process. Using entire neutrophil cell membranes, we're cutting off all these inflammatory signals at once," said first author Qiangzhe Zhang, a Ph.D. student in Professor Liangfang Zhang's research group at UC San Diego.

To make the neutrophil nanosponges, the researchers first developed a method to separate neutrophils from whole blood. They then processed the cells in a solution that causes them to swell and burst, leaving the membranes behind. The membranes were then broken up into much smaller pieces. Mixing them with ball-shaped nanoparticles made of biodegradable polymer fused the neutrophil cell membranes onto the nanoparticle surfaces.

"One of the major challenges of this work was streamlining this entire process, from isolating neutrophils from blood to removing the membranes, and making this process repeatable. We spent a lot of time figuring this out and eventually created a consistent neutrophil nanosponge production line," said Qiangzhe Zhang.

In mouse models of severe rheumatoid arthritis, injecting nanosponges in inflamed joints led to reduced swelling and protected cartilage from further damage. The nanosponges performed just as well as treatments in which mice were administered a high dose of monoclonal antibodies.

The nanosponges also worked as a preventive treatment when administered prior to inducing the disease in another group of mice.

Professor Liangfang Zhang cautions that the nanosponge treatment does not eliminate the disease. "We are basically able to manage the disease. It's not completely gone. But swelling is greatly reduced and cartilage damage is minimized," he said.

The team hopes to one day see their work in clinical trials.

Terahertz spectroscopy enters the single-molecule regime -- ScienceDaily

The interaction of light with matter is the basis of spectroscopy, a set of techniques lying at the heart of physics and chemistry. From infrared light to X-rays, a broad sweep of wavelengths is used to stimulate vibrations, electron transitions, and other processes, thus probing the world of atoms and molecules.

However, one lesser-used form of light is the terahertz (THz) region. Lying on the electromagnetic spectrum between infrared and microwaves, THz radiation does have the right frequency (around 10^12 Hz) to excite molecular vibrations. Unfortunately, its long wavelength (hundreds of micrometers) is around 100,000 times a typical molecular size, making it impossible to focus THz beams onto a single molecule by conventional optics. Only large ensembles of molecules can be studied.

Recently, a team led by The University of Tokyo's Institute of Industrial Science (IIS) found a way around this problem. In a study in *Nature Photonics*, they showed that THz radiation can indeed detect the motion of individual molecules, overcoming the classical diffraction limit for focusing light beams. In fact, the method was sensitive enough to measure the tunneling of a single electron.

The IIS team showcased a nanoscale design known as a single-molecule transistor. Two adjacent metal electrodes, the source and the drain of the transistor, are placed on a thin silicon wafer in a "bowtie" shape. Then, single molecules -- in this case C60, aka fullerene -- are deposited in the sub-nanometer gaps between the source and drain. The electrodes act as antennas to tightly focus the THz beam onto the isolated fullerenes.

"The fullerenes absorb the focused THz radiation, making them oscillate around their center-of-mass," explains study first-author Shaoqing Du. "The ultrafast molecular oscillation raises the electric current in the transistor, on

top of its inherent conductivity." Although this current change is minuscule -- on the order of femto-amps (fA) -- it can be precisely measured with the same electrodes used to trap the molecules. In this way, two vibrational peaks at around 0.5 and 1 THz were plotted.

In fact, the measurement is sensitive enough to measure a slight splitting of the absorption peaks, caused by adding or subtracting only one electron. When C60 oscillates on a metal surface, its vibrational quantum (vibron) can be absorbed by an electron in the metal electrode. Thus stimulated, the electron tunnels into the C60 molecule. The resulting negatively charged C60? molecule vibrates at a slightly lower frequency than neutral C60, thus absorbing a different frequency of THz radiation.

Apart from providing a glimpse of tunneling, the study demonstrates a practical method to obtain electronic and vibronic information on molecules that only weakly absorb THz photons. This could open up the wider use of THz spectroscopy, an under-developed method that is complementary to visible-light and X-ray spectroscopy, and highly relevant to nanoelectronics and quantum computing.

Story Source:

Materials provided by **Institute of Industrial Science, The University of Tokyo**. *Note: Content may be edited for style and length.*

Scientists pioneer a new way to turn sunlight into fuel: New research in the field of semi-artificial photosynthesis -- ScienceDaily

The quest to find new ways to harness solar power has taken a step forward after researchers successfully split water into hydrogen and oxygen by altering the photosynthetic machinery in plants.

Photosynthesis is the process plants use to convert sunlight into energy. Oxygen is produced as by-product of photosynthesis when the water absorbed by plants is 'split'. It is one of the most important reactions on the planet because it is the source of nearly all of the world's oxygen. Hydrogen which is produced when the water is split could potentially be a green and unlimited source of renewable energy.

A new study, led by academics at St John's College, University of Cambridge, used semi-artificial photosynthesis to explore new ways to produce and store solar energy. They used natural sunlight to convert water into hydrogen and oxygen using a mixture of biological components and humanmade technologies.

The research could now be used to revolutionise the systems used for renewable energy production. A new paper, published in *Nature Energy*, outlines how academics at the Reisner Laboratory in Cambridge developed their platform to achieve unassisted solar-driven water-splitting.

Their method also managed to absorb more solar light than natural photosynthesis.

Katarzyna Sokól, first author and PhD student at St John's College, said: "Natural photosynthesis is not efficient because it has evolved merely to survive so it makes the bare minimum amount of energy needed -- around 1-2

per cent of what it could potentially convert and store."

Artificial photosynthesis has been around for decades but it has not yet been successfully used to create renewable energy because it relies on the use of catalysts, which are often expensive and toxic. This means it can't yet be used to scale up findings to an industrial level.

The Cambridge research is part of the emerging field of semi-artificial photosynthesis which aims to overcome the limitations of fully artificial photosynthesis by using enzymes to create the desired reaction.

Sokól and the team of researchers not only improved on the amount of energy produced and stored, they managed to reactivate a process in the algae that has been dormant for millennia.

She explained: "Hydrogenase is an enzyme present in algae that is capable of reducing protons into hydrogen. During evolution this process has been deactivated because it wasn't necessary for survival but we successfully managed to bypass the inactivity to achieve the reaction we wanted -- splitting water into hydrogen and oxygen."

Sokól hopes the findings will enable new innovative model systems for solar energy conversion to be developed.

She added: "It's exciting that we can selectively choose the processes we want, and achieve the reaction we want which is inaccessible in nature. This could be a great platform for developing solar technologies. The approach could be used to couple other reactions together to see what can be done, learn from these reactions and then build synthetic, more robust pieces of solar energy technology."

This model is the first to successfully use hydrogenase and photosystem II to create semi-artificial photosynthesis driven purely by solar power.

Dr Erwin Reisner, Head of the Reisner Laboratory, a Fellow of St John's College, University of Cambridge, and one of the paper's authors described the research as a 'milestone'.

He explained: ""This work overcomes many difficult challenges associated with the integration of biological and organic components into inorganic materials for the assembly of semi-artificial devices and opens up a toolbox for developing future systems for solar energy conversion."

Story Source:

Little star sheds light on young planets: Astronomers discover new stage in evolution of young solar systems -- ScienceDaily

Early in 2017, Assistant Professor Yoko Oya gave graduate student Yuki Okoda some recent complex data on a nearby star with which she could begin her Ph.D. Little did she realize that what she would find could unlock not only the secrets of how planets form but possibly her career as a professional astronomer.

The star in question (only known by its catalog number IRAS 15398-3359) is small, young and relatively cool for a star. It's diminutive stature means the weak light it shines can't even reach us through a cloud of gas and dust that surrounds it. But this doesn't stop inquisitive minds from exploring the unknown.

In 2013, Oya and her collaborators used the Atacama Large Millimeter/submillimeter Array (ALMA) in Chile to observe the star in submillimeter wavelengths, as that kind of light can penetrate the dust cloud -- for reference, red light is around 700 nanometers. A painstaking analysis revealed some interesting nebulous structures, despite the images they worked from being difficult to comprehend.

"The greatest academic challenge I've faced was trying to make sense of grainy images. It's extremely difficult to know exactly what you're really looking at." says Okoda. "But I felt compelled to explore the nature of the structures Dr. Oya had seen with ALMA, so I came up with a model to explain them." The model she produced came as a surprise to Okoda and her colleagues, but it fit the data perfectly. It describes a dense disk of material that consists of gas and dust from the cloud that surrounds the star. This has never before been seen around such a young star.

The disk is a precursor to a protoplanetary disk, which is far denser still and eventually becomes a planetary system in orbit around a star.

"We can't say for sure this particular disk will coalesce into a new planetary system," explains Oya. "The dust cloud may be pushed away by stellar winds or it might all fall into the star itself, feeding it in the process. What's exciting is how quickly this might happen."

The star is small at around 0.7 percent the mass of our sun, based on observations of the mass of the surrounding cloud. It could grow to as large as 20 percent in just a few tens of thousands of years, a blink of the eye on the cosmic scale.

"I hope our observations and models will enhance knowledge of how solar systems form," says Okoda. "My research interests involve young protostellar objects, and the implication that protoplanetary disks could form earlier than expected really excites me."

Okoda began this project a year-and-a-half ago to hone her skills as an astronomer, but mirroring the young star she observed, the practice evolved quickly and became a full research project, which will hopefully earn her a Ph.D. from the University of Tokyo.

The observations and resultant model were only possible thanks to advancements in radio astronomy with observatories such as ALMA. The team was lucky that the plane of the disk is level with our own solar system as this means the starlight ALMA sees passes through enough of the gas and dust to divulge important characteristics of it.

"We were also lucky to be given time with ALMA to carry out our observations. Only about 20 percent of applications actually go ahead," explains Oya. "With highly specialized astronomical instruments, there is much competition for time. My hope is our success will inspire a new generation of astronomers in Japan to reach for the stars."

Story Source:

Materials provided by **University of Tokyo**. *Note: Content may be edited for*

style and length.

A new way to remove ice buildup without power or chemicals: Passive solar-powered system could prevent freezing on airplanes, wind turbines, powerlines, and other surfaces -- ScienceDaily

From airplane wings to overhead powerlines to the giant blades of wind turbines, a buildup of ice can cause problems ranging from impaired performance all the way to catastrophic failure. But preventing that buildup usually requires energy-intensive heating systems or chemical sprays that are environmentally harmful. Now, MIT researchers have developed a completely passive, solar-powered way of combating ice buildup.

The system is remarkably simple, based on a three-layered material that can be applied or even sprayed onto the surfaces to be treated. It collects solar radiation, converts it to heat, and spreads that heat around so that the melting is not just confined to the areas exposed directly to the sunlight. And, once applied, it requires no further action or power source. It can even do its de-icing work at night, using artificial lighting.

The new system is described today in the journal *Science Advances*, in a paper by MIT associate professor of mechanical engineering Kripa Varanasi and postdocs Susmita Dash and Jolet de Ruiter.

"Icing is a major problem for aircraft, for wind turbines, powerlines, offshore oil platforms, and many other places," Varanasi says. "The conventional ways of getting around it are de-icing sprays or by heating, but those have issues."

Inspired by the sun

The usual de-icing sprays for aircraft and other applications use ethylene

glycol, a chemical that is environmentally unfriendly. Airlines don't like to use active heating, both for cost and safety reasons. Varanasi and other researchers have investigated the use of superhydrophobic surfaces to prevent icing passively, but those coatings can be impaired by frost formation, which tends to fill the microscopic textures that give the surface its ice-shedding properties.

As an alternate line of inquiry, Varanasi and his team considered the energy given off by the sun. They wanted to see, he says, whether "there is a way to capture that heat and use it in a passive approach." They found that there was.

It's not necessary to produce enough heat to melt the bulk of the ice that forms, the team found. All that's needed is for the boundary layer, right where the ice meets the surface, to melt enough to create a thin layer of water, which will make the surface slippery enough so any ice will just slide right off. This is what the team has achieved with the three-layered material they've developed.

Layer by layer

The top layer is an absorber, which traps incoming sunlight and converts it to heat. The material the team used is highly efficient, absorbing 95 percent of the incident sunlight, and losing only 3 percent to re-radiation, Varanasi says

In principle, that layer could in itself help to prevent frost formation, but with two limitations: It would only work in the areas directly in sunlight, and much of the heat would be lost back into the substrate material -- the airplane wing or powerline, for example -- and would not help with the de-icing.

So, to compensate for the localization, the team added a spreader layer -- a very thin layer of aluminum, just 400 micrometers thick, which is heated by the absorber layer above it and very efficiently spreads that heat out laterally to cover the entire surface. The material was selected to have "thermal response that is fast enough so that the heating takes place faster than the freezing," Varanasi says.

Finally, the bottom layer is simply foam insulation, to keep any of that heat from being wasted downward and keep it where it's needed, at the surface.

"In addition to passive de-icing, the photothermal trap stays at an elevated temperature, thus preventing ice build-up altogether," Dash says.

The three layers, all made of inexpensive commercially available material, are then bonded together, and can be bonded to the surface that needs to be protected. For some applications, the materials could instead be sprayed onto a surface, one layer at a time, the researchers say.

The team carried out extensive tests, including real-world outdoor testing of the materials and detailed laboratory measurements, to prove the effectiveness of the system.

The system could even find wider commercial uses, such as panels to prevent icing on roofs of homes, schools, and other buildings, Varanasi says. The team is planning to continue work on the system, testing it for longevity and for optimal methods of application. But the basic system could essentially be applied almost immediately for some uses, especially stationary applications, he says.

Sound can be used to print droplets that couldn't be printed before -- ScienceDaily

Harvard University researchers have developed a new printing method that uses sound waves to generate droplets from liquids with an unprecedented range of composition and viscosity. This technique could finally enable the manufacturing of many new biopharmaceuticals, cosmetics, and food and expand the possibilities of optical and conductive materials.

"By harnessing acoustic forces, we have created a new technology that enables myriad materials to be printed in a drop-on-demand manner," said Jennifer Lewis, the Hansjorg Wyss Professor of Biologically Inspired Engineering at the Harvard John A. Paulson School of Engineering and Applied Sciences and the senior author of the paper.

Lewis is also a Core Faculty Member at the Wyss Institute for Biologically Inspired Engineering and the Jianming Yu Professor of Arts and Sciences at Harvard.

The research is published in *Science Advances*.

Liquid droplets are used in many applications from printing ink on paper to creating microcapsules for drug delivery. Inkjet printing is the most common technique used to pattern liquid droplets, but it's only suitable for liquids that are roughly 10 times more viscous than water. Yet many fluids of interest to researchers are far more viscous. For example, biopolymer and cell-laden solutions, which are vital for biopharmaceuticals and bioprinting, are at least 100 times more viscous than water. Some sugar-based biopolymers could be as viscous as honey, which is 25,000 times more viscous than water.

The viscosity of these fluids also changes dramatically with temperature and composition, makes it even more difficult to optimize printing parameters to control droplet sizes.

"Our goal was to take viscosity out of the picture by developing a printing system that is independent from the material properties of the fluid," said Daniele Foresti, first author of the paper, the Branco Weiss Fellow and Research Associate in Materials Science and Mechanical Engineering at SEAS and the Wyss Institute.

To do that, the researchers turned to acoustic waves.

Thanks to gravity, any liquid can drip -- from water dripping out of a faucet to the century-long pitch drop experiment. With gravity alone, droplet size remains large and drop rate difficult to control. Pitch, which has a viscosity roughly 200 billion times that of water, forms a single drop per decade.

To enhance drop formation, the research team relies on generating sound waves. These pressure waves have been typically used to defy gravity, as in the case of acoustic levitation. Now, the researchers are using them to assist gravity, dubbing this new technique acoustophoretic printing.

The researchers built a subwavelength acoustic resonator that can generate a highly confined acoustic field resulting in a pulling force exceeding 100 times the normal gravitation forces (1 G) at the tip of the printer nozzle -- that's more than four times the gravitational force on the surface of the sun.

This controllable force pulls each droplet off of the nozzle when it reaches a specific size and ejects it towards the printing target. The higher the amplitude of the sound waves, the smaller the droplet size, irrespective of the viscosity of the fluid.

"The idea is to generate an acoustic field that literally detaches tiny droplets from the nozzle, much like picking apples from a tree," said Foresti.

The researchers tested the process on a wide range of materials from honey to stem-cell inks, biopolymers, optical resins and, even, liquid metals. Importantly, sound waves don't travel through the droplet, making the method safe to use even with sensitive biological cargo, such as living cells or proteins.

"Our technology should have an immediate impact on the pharmaceutical

industry," said Lewis. "However, we believe that this will become an important platform for multiple industries."

"This is an exquisite and impactful example of the breadth and reach of collaborative research," said Dan Finotello, director of NSF's MRSEC program. "The authors have developed a new printing platform using acoustic-forces, which, unlike in other methods, are material-independent and thus offer tremendous printing versatility. The application space is limitless."

The Harvard Office of Technology Development has protected the intellectual property relating to this project and is exploring commercialization opportunities.

This research was co-authored by Katharina Kroll, Robert Amissah, Francesco Sillani, Kimberly Homan and Dimos Poulikakos. It was funded by Society in Science through the Branco Weiss Fellowship and the National Science Foundation through Harvard MRSEC.

Video: https://www.youtube.com/watch?v=FCbxfe9F6fs

Better silicone adhesion Inspired by beetle feet -- ScienceDaily

Geckos, spiders and beetles have shown us how to do it: thanks to special adhesive elements on their feet, they can easily run along ceilings or walls. The science of bionics tries to imitate and control such biological functions, for technological applications and the creation of artificial materials. A research team from Kiel University (CAU) has now succeeded in boosting the adhesive effect of a silicone material significantly. To do so they combined two methods: First, they structured the surface on the micro scale based on the example of beetle feet, and thereafter treated it with plasma. In addition, they found out that the adhesiveness of the structured material changes drastically, if it is bent to varying degrees. Among other areas of application, their results could be interesting for the development of tiny robots and gripping devices. They have been published in the latest editions of the scientific journals *Advanced Materials* and *ACS Applied Materials & Interfaces*.

Elastic synthetic materials such as silicone elastomers are very popular in industry. They are flexible, re-usable, cheap and easy to produce. They are therefore used for example as seals, for insulation or as corrosion protection. However, due to their low surface energy, they are hardly adhesive at all. This makes it difficult, for example, to paint silicone surfaces.

Surfaces with a mushroom-like microstructure adhere much better

Professor Stanislav N. Gorb and Emre Kizilkan from the Functional Morphology and Biomechanics working group are researching how to improve the adhesive properties of silicone elastomers. Their example to mimic is the surface structure of certain male leaf beetles (Chrysomelidae), looking like mushrooms. In two recent studies, they discovered that silicone elastomers adhere best if their surface is modified into mushroom-like structures and thereafter specifically treated with plasma. The electrically-charged gas which is the fourth state of matter, alongside solids, liquids and

gases. Thus, the researchers combined a geometrical and a chemical method, to imitate biology. In addition, they showed that the degree of curvature of the materials affects their adhesion.

"Animals and plants provide us with a wealth of experience about some incredible features. We want to transfer the mechanisms behind them to artificial materials, to be able to control their behaviour in a targeted manner," said the zoologist Gorb. Their goal of a reversible adhesion in the micro range without traditional glue could make completely new application possibilities conceivable -- for example in micro-electronics.

During experimental tests silicones are curved

In a first step, the research team compared silicone elastomers of three different surfaces: one unstructured, one with pillar-shaped elements and a third with a mushroom-like structure. Using a micro-manipulator, they stuck a glass ball onto the surfaces and then removed it again. They tested how the adhesion changes when the materials with microstructured surfaces are bent convex (inwards) and concave (outwards). "In this way, we were able to demonstrate that silicone materials with a mushroom-like structure and curved concave have the double range of adhesive strength," said doctoral researcher Emre Kizilkan, first author of the study. "With this surface structure, we can vary and control the adhesion of materials the most."

Exact parameters for material-friendly plasma treatment

In a second step, the scientists treated the silicone elastomers with plasmas. This method is normally used to functionalise plastic materials, in order to increase their surface energy and to improve their adhesive properties. In comparison with other methods using liquids, plasma treatments can promise greater longevity -- however, they often damage the surfaces of materials.

To find out how plasma treatments can significantly improve the adhesion of a material without damaging it, the scientists varied different parameters, such as the duration or the pressure. They found that the adhesion of unstructured surfaces on a glass substrate increased by approximately 30% after plasma treatment. On the mushroom-like structured surface the adhesion even increased by up to 91%. "These findings particularly surprised us,

because the structured surface is only half as large as the unstructured, but adhesion enhancement was even three times better after the plasma treatment," explained Kizilkan.

What happens when the treated and non-treated structured surfaces are removed from the glass substrate show the recordings with a high-speed camera: Because of its higher surface energy the plasma-treated microstructure remains fully in contact with the surface of the glass for 50,6 seconds. However, the contact area of the untreated microstructure is reduced quickly by around one third during the removal process, which is why the microstructure completely detaches from the glass substrate after 33 seconds already (Figure 3).

Especially suitable for applications in microelectronics

"We therefore have on a very small area an extremely strong adhesion with a wide range," summarizes the material scientist Kizilkan. This makes the results especially interesting for small-scale applications such as micro-robots. The findings of the Kiel working group have already resulted in the development of an extremely strong adhesive tape, which functions according to the "gecko principle," and can be removed without leaving any residue.

Story Source:

Materials provided by **Kiel University**. *Note: Content may be edited for style and length.*

The low impact of the high-speed train on international tourism -- ScienceDaily

At the height of the tourist season, a study by the Applied Economics & Management, Research Group, based at the University of Seville, is a pioneering analysis of the relationship between the high-speed train and tourism in Europe, in contrast with tourism's relationship with the plane.

For the Economics Professor, José Ignacio Castillo Manzano, there is undeniably a complementary relationship between air travel and the high-speed train, which would justify the development of joint strategies, starting with rail connections between airports and railway stations with high-speed connections, and going as far as joint plane and high-speed train tickets, as are already sold by one airline. However, and although both means of transport favour tourism, European experience indicates that their influence is very different.

The plane has a close and direct relationship with both national and international tourism. Additionally, not only is it related to a higher volume of visitors, but there is also a relationship with longer stays, especially for international tourism.

In contrast, according to Castillo Manzano, "the relationship the high-speed train has is mostly with national tourism, and it lacks any significant influence on international tourism." For the professor, in the case of Spain, "a larger presence of foreign tourists on the AVE in Spain would act as a mere optical illusion on the supposed relevance of this means of transport on international tourism as, really, the great majority of these tourists have come via the many and cheap flight connections that our airports offer. If the AVE network did not exist, these tourists would instead travel around the country using the greater number of and more frequent domestic flight connections that would exist if the AVE wasn't there." According to this study, there is not even any empirical evidence that, thanks to high-speed train connections, foreign tourists extend their stays in the country.

Of course, the relationship of the high-speed train with national tourism is much closer and more positive than the plane's. But, for Castillo Manzano, the share of earnings that are generated by our high-speed train in the fomentation of domestic tourism remains to be studied. Giving as an example the first AVE line between Madrid and Seville, he explains that "although there is no doubt that this was very important in Seville being able to attract many more tourists from the centre of the peninsula, especially in the nineties, while the planned high-speed train network has been developed, incorporating new cities, it is very probable that the more significant part of the money earned goes to Madrid. Doubtlessly, what has happened is a significant improvement in access facilities from our country's main cities to the capital. Thanks to the AVE, Madrid is now the easiest place to organise a national conference, a work meeting or for ordinary Spanish people to have a weekend break to, for example, see a musical or a new exhibition at the Prado. However, tourists that come from Madrid do not only head for Seville, rather they visit different cities on the AVE."

On the other hand, the study also concludes that those countries with a lower per capita income and lower prices in the tourist sector are those that attract more foreign tourists, whereas the more developed a country is, the more national tourism it generates. So, for the professor, encouraging the economic development of a country is also a magnificent policy for promoting domestic tourism.

In contrast, if we are speaking about attracting foreign tourism, for Castillo good airport management and infrastructure is fundamental. "There are few more effective tourism policies than the setting of optimal airport taxes that favour the opening of new routes and increased flight frequency and combat the highly seasonal nature of the tourism industry." In this way, "the good working of the pairing of transport and tourism is the best guarantee of the future of the sector, hence the need to contribute to finding long-term solutions to problems related to transport that threaten, as with the taxi sector, systemic delays at some airports, or labour problems as experienced by Ryanair."

Story Source:

Materials provided by **University of Seville**. *Note: Content may be edited for*

style and length.

Cannibalistic materials feed on themselves to grow new nanostructures -- ScienceDaily

Scientists at the Department of Energy's Oak Ridge National Laboratory induced a two-dimensional material to cannibalize itself for atomic "building blocks" from which stable structures formed.

The findings, reported in *Nature Communications*, provide insights that may improve design of 2D materials for fast-charging energy-storage and electronic devices.

"Under our experimental conditions, titanium and carbon atoms can spontaneously form an atomically thin layer of 2D transition-metal carbide, which was never observed before," said Xiahan Sang of ORNL.

He and ORNL's Raymond Unocic led a team that performed in situ experiments using state-of-the-art scanning transmission electron microscopy (STEM), combined with theory-based simulations, to reveal the mechanism's atomistic details.

"This study is about determining the atomic-level mechanisms and kinetics that are responsible for forming new structures of a 2D transition-metal carbide such that new synthesis methods can be realized for this class of materials," Unocic added.

The starting material was a 2D ceramic called a MXene (pronounced "max een"). Unlike most ceramics, MXenes are good electrical conductors because they are made from alternating atomic layers of carbon or nitrogen sandwiched within transition metals like titanium.

The research was a project of the Fluid Interface Reactions, Structures and Transport (FIRST) Center, a DOE Energy Frontier Research Center that explores fluid-solid interface reactions that have consequences for energy transport in everyday applications. Scientists conducted experiments to

synthesize and characterize advanced materials and performed theory and simulation work to explain observed structural and functional properties of the materials. New knowledge from FIRST projects provides guideposts for future studies.

The high-quality material used in these experiments was synthesized by Drexel University scientists, in the form of five-ply single-crystal monolayer flakes of MXene. The flakes were taken from a parent crystal called "MAX," which contains a transition metal denoted by "M"; an element such as aluminum or silicon, denoted by "A"; and either a carbon or nitrogen atom, denoted by "X." The researchers used an acidic solution to etch out the monoatomic aluminum layers, exfoliate the material and delaminate it into individual monolayers of a titanium carbide MXene (Ti_3C_2).

The ORNL scientists suspended a large MXene flake on a heating chip with holes drilled in it so no support material, or substrate, interfered with the flake. Under vacuum, the suspended flake was exposed to heat and irradiated with an electron beam to clean the MXene surface and fully expose the layer of titanium atoms.

MXenes are typically inert because their surfaces are covered with protective functional groups -- oxygen, hydrogen and fluorine atoms that remain after acid exfoliation. After protective groups are removed, the remaining material activates. Atomic-scale defects -- "vacancies" created when titanium atoms are removed during etching -- are exposed on the outer ply of the monolayer. "These atomic vacancies are good initiation sites," Sang said. "It's favorable for titanium and carbon atoms to move from defective sites to the surface." In an area with a defect, a pore may form when atoms migrate.

"Once those functional groups are gone, now you're left with a bare titanium layer (and underneath, alternating carbon, titanium, carbon, titanium) that's free to reconstruct and form new structures on top of existing structures," Sang said.

High-resolution STEM imaging proved that atoms moved from one part of the material to another to build structures. Because the material feeds on itself, the growth mechanism is cannibalistic.

"The growth mechanism is completely supported by density functional theory and reactive molecular dynamics simulations, thus opening up future possibilities to use these theory tools to determine the experimental parameters required for synthesizing specific defect structures," said Adri van Duin of Penn State.

Most of the time, only one additional layer [of carbon and titanium] grew on a surface. The material changed as atoms built new layers. Ti3C2 turned into Ti4C3, for example.

"These materials are efficient at ionic transport, which lends itself well to battery and supercapacitor applications," Unocic said. "How does ionic transport change when we add more layers to nanometer-thin MXene sheets?" This question may spur future studies.

"Because MXenes containing molybdenum, niobium, vanadium, tantalum, hafnium, chromium and other metals are available, there are opportunities to make a variety of new structures containing more than three or four metal atoms in cross-section (the current limit for MXenes produced from MAX phases)," Yury Gogotsi of Drexel University added. "Those materials may show different useful properties and create an array of 2D building blocks for advancing technology."

At ORNL's Center for Nanophase Materials Sciences (CNMS), Yu Xie, Weiwei Sun and Paul Kent performed first-principles theory calculations to explain why these materials grew layer by layer instead of forming alternate structures, such as squares. Xufan Li and Kai Xiao helped understand the growth mechanism, which minimizes surface energy to stabilize atomic configurations. Penn State scientists conducted large-scale dynamical reactive force field simulations showing how atoms rearranged on surfaces, confirming defect structures and their evolution as observed in experiments.

The researchers hope the new knowledge will help others grow advanced materials and generate useful nanoscale structures.

Water worlds could support life, study says: Scientists challenges idea that life requires 'Earth clone' -- ScienceDaily

The conditions for life surviving on planets entirely covered in water are more fluid than previously thought, opening up the possibility that water worlds could be habitable, according to a new paper from the University of Chicago and Pennsylvania State University.

The scientific community has largely assumed that planets covered in a deep ocean would not support the cycling of minerals and gases that keeps the climate stable on Earth, and thus wouldn't be friendly to life. But the study, published Aug. 30 in The *Astrophysical Journal*, found that ocean planets could stay in the "sweet spot" for habitability much longer than previously assumed. The authors based their findings on more than a thousand simulations.

"This really pushes back against the idea you need an Earth clone -- that is, a planet with some land and a shallow ocean," said Edwin Kite, assistant professor of geophysical sciences at UChicago and lead author of the study.

As telescopes get better, scientists are finding more and more planets orbiting stars in other solar systems. Such discoveries are resulting in new research into how life could potentially survive on other planets, some of which are very different from Earth -- some may be covered entirely in water hundreds of miles deep.

Because life needs an extended period to evolve, and because the light and heat on planets can change as their stars age, scientists usually look for planets that have both some water and some way to keep their climates stable over time. The primary method we know of is how Earth does it. Over long timescales, our planet cools itself by drawing down greenhouse gases into minerals and warms itself up by releasing them via volcanoes.

But this model doesn't work on a water world, with deep water covering the rock and suppressing volcanoes.

Kite, and Penn State coauthor Eric Ford, wanted to know if there was another way. They set up a simulation with thousands of randomly generated planets, and tracked the evolution of their climates over billions of years.

"The surprise was that many of them stay stable for more than a billion years, just by luck of the draw," Kite said. "Our best guess is that it's on the order of 10 percent of them."

These lucky planets sit in the right location around their stars. They happened to have the right amount of carbon present, and they don't have too many minerals and elements from the crust dissolved in the oceans that would pull carbon out of the atmosphere. They have enough water from the start, and they cycle carbon between the atmosphere and ocean only, which in the right concentrations is sufficient to keep things stable.

"How much time a planet has is basically dependent on carbon dioxide and how it's partitioned between the ocean, atmosphere and rocks in its early years," said Kite. "It does seem there is a way to keep a planet habitable long-term without the geochemical cycling we see on Earth."

The simulations assumed stars that are like our own, but the results are optimistic for red dwarf stars, too, Kite said. Planets in red dwarf systems are thought to be promising candidates for fostering life because these stars get brighter much more slowly than our sun -- giving life a much longer time period to get started. The same conditions modeled in this paper could be applied to planets around red dwarfs, they said: Theoretically, all you would need is the steady light of a star.

Story Source:

Materials provided by **University of Chicago**. *Note: Content may be edited for style and length.*

Model can more naturally detect depression in conversations: Neural network learns speech patterns that predict depression in clinical interviews -- ScienceDaily

To diagnose depression, clinicians interview patients, asking specific questions -- about, say, past mental illnesses, lifestyle, and mood -- and identify the condition based on the patient's responses.

In recent years, machine learning has been championed as a useful aid for diagnostics. Machine-learning models, for instance, have been developed that can detect words and intonations of speech that may indicate depression. But these models tend to predict that a person is depressed or not, based on the person's specific answers to specific questions. These methods are accurate, but their reliance on the type of question being asked limits how and where they can be used.

In a paper being presented at the Interspeech conference, MIT researchers detail a neural-network model that can be unleashed on raw text and audio data from interviews to discover speech patterns indicative of depression. Given a new subject, it can accurately predict if the individual is depressed, without needing any other information about the questions and answers.

The researchers hope this method can be used to develop tools to detect signs of depression in natural conversation. In the future, the model could, for instance, power mobile apps that monitor a user's text and voice for mental distress and send alerts. This could be especially useful for those who can't get to a clinician for an initial diagnosis, due to distance, cost, or a lack of awareness that something may be wrong.

"The first hints we have that a person is happy, excited, sad, or has some serious cognitive condition, such as depression, is through their speech," says

first author Tuka Alhanai, a researcher in the Computer Science and Artificial Intelligence Laboratory (CSAIL). "If you want to deploy [depression-detection] models in scalable way ... you want to minimize the amount of constraints you have on the data you're using. You want to deploy it in any regular conversation and have the model pick up, from the natural interaction, the state of the individual."

The technology could still, of course, be used for identifying mental distress in casual conversations in clinical offices, adds co-author James Glass, a senior research scientist in CSAIL. "Every patient will talk differently, and if the model sees changes maybe it will be a flag to the doctors," he says. "This is a step forward in seeing if we can do something assistive to help clinicians."

The other co-author on the paper is Mohammad Ghassemi, a member of the Institute for Medical Engineering and Science (IMES).

Context-free modeling

The key innovation of the model lies in its ability to detect patterns indicative of depression, and then map those patterns to new individuals, with no additional information. "We call it 'context-free,' because you're not putting any constraints into the types of questions you're looking for and the type of responses to those questions," Alhanai says.

Other models are provided with a specific set of questions, and then given examples of how a person without depression responds and examples of how a person with depression responds -- for example, the straightforward inquiry, "Do you have a history of depression?" It uses those exact responses to then determine if a new individual is depressed when asked the exact same question. "But that's not how natural conversations work," Alhanai says.

The researchers, on the other hand, used a technique called sequence modeling, often used for speech processing. With this technique, they fed the model sequences of text and audio data from questions and answers, from both depressed and non-depressed individuals, one by one. As the sequences accumulated, the model extracted speech patterns that emerged for people with or without depression. Words such as, say, "sad," "low," or "down," may

be paired with audio signals that are flatter and more monotone.

Individuals with depression may also speak slower and use longer pauses between words. These text and audio identifiers for mental distress have been explored in previous research. It was ultimately up to the model to determine if any patterns were predictive of depression or not.

"The model sees sequences of words or speaking style, and determines that these patterns are more likely to be seen in people who are depressed or not depressed," Alhanai says. "Then, if it sees the same sequences in new subjects, it can predict if they're depressed too."

This sequencing technique also helps the model look at the conversation as a whole and note differences between how people with and without depression speak over time.

Detecting depression

The researchers trained and tested their model on a dataset of 142 interactions from the Distress Analysis Interview Corpus that contains audio, text, and video interviews of patients with mental-health issues and virtual agents controlled by humans. Each subject is rated in terms of depression on a scale between 0 to 27, using the Personal Health Questionnaire. Scores above a cutoff between moderate (10 to 14) and moderately severe (15 to 19) are considered depressed, while all others below that threshold are considered not depressed. Out of all the subjects in the dataset, 28 (20 percent) are labeled as depressed.

In experiments, the model was evaluated using metrics of precision and recall. Precision measures which of the depressed subjects identified by the model were diagnosed as depressed. Recall measures the accuracy of the model in detecting all subjects who were diagnosed as depressed in the entire dataset. In precision, the model scored 71 percent and, on recall, scored 83 percent. The averaged combined score for those metrics, considering any errors, was 77 percent. In the majority of tests, the researchers' model outperformed nearly all other models.

One key insight from the research, Alhanai notes, is that, during experiments,

the model needed much more data to predict depression from audio than text. With text, the model can accurately detect depression using an average of seven question-answer sequences. With audio, the model needed around 30 sequences. "That implies that the patterns in words people use that are predictive of depression happen in shorter time span in text than in audio," Alhanai says. Such insights could help the MIT researchers, and others, further refine their models.

This work represents a "very encouraging" pilot, Glass says. But now the researchers seek to discover what specific patterns the model identifies across scores of raw data.

"Right now it's a bit of a black box," Glass says. "These systems, however, are more believable when you have an explanation of what they're picking up. ... The next challenge is finding out what data it's seized upon."

The researchers also aim to test these methods on additional data from many more subjects with other cognitive conditions, such as dementia. "It's not so much detecting depression, but it's a similar concept of evaluating, from an everyday signal in speech, if someone has cognitive impairment or not," Alhanai says.

Using physics to predict crowd behavior -- ScienceDaily

Electrons whizzing around each other and humans crammed together at a political rally don't seem to have much in common, but researchers at Cornell are connecting the dots.

They've developed a highly accurate mathematical approach to predict the behavior of crowds of living creatures, using Nobel Prize-winning methods originally developed to study large collections of quantum mechanically interacting electrons. The implications for the study of human behavior are profound, according to the researchers.

For example, by using publicly available video data of crowds in public spaces, their approach could predict how people would distribute themselves under extreme crowding. By measuring density fluctuations using a smartphone app, the approach could describe the current behavioral state or mood of a crowd, providing an early warning system for crowds shifting toward dangerous behavior.

Tomas Arias, professor of physics, is lead author of "Density-Functional Fluctuation Theory of Crowds," which published Aug. 30 in *Nature Communications*. Co-authors include Itai Cohen, professor of physics; and Yunus A. Kinkhabwala, a doctoral student in the field of engineering.

Interactions among individuals in a crowd can be complex and difficult to quantify mathematically; the large number of actors in a crowd results in a complex mathematical problem. The researchers sought to predict the behavior of crowds by using simple measurements of density to infer underlying interactions and to use those interactions to predict new behaviors.

To achieve this, they applied mathematical concepts and approaches from density-functional theory (DFT), a branch of many-body physics developed for quantum mechanical systems, to the behavior of crowds.

"This is one of the all-too-rare cases -- particularly where living systems are involved -- where the theory preceded the experiments, and the experiments, in precise mathematical detail, completely confirmed the theory," said Arias.

To test their theory, the researchers created a model system using walking fruit flies (*Drosophila melanogaster*). They first demonstrated a mathematical way to extract functions that quantify how much the flies like different locations in their environment -- the "vexation" function -- and how much they mind crowding together -- the "frustration" function based on the details of how the population densities change as the flies more around.

They then showed that by mixing and matching this information with observations of a single fly in an entirely new environment, they could accurately predict, before any observations, how a large crowd of flies would distribute themselves in that new environment. They also tracked changes in the overall behavior of the crowd -- i.e., its "mood" -- by tracking evolution of the social preference "frustration" function.

While fruit flies were "a convenient, and ethical, first test system," Arias said, the behavior of a crowd at a political rally would provide a human example of DFT theory. Individuals will try to find the best location to stand -- typically closest to the stage -- while avoiding overcrowded areas. When new and better locations become available, individuals are likely to move toward them.

To develop a mathematically predictive theory, the researchers associated a number -- the vexation function -- with the intrinsic desirability of each location; the lowest value would be at the ideal location, closest to the stage. The frustration function accounts for the undesirability of crowding effects, and a behavioral rule accounts for the tendency of individuals to look for better locations.

"The remarkable mathematical discovery," Arias said, "is that precise values for vexation and frustration can be obtained instantly and automatically, simply by observing changes in crowding as the crowd mills around, without the need for any kind of survey to ask people in the crowd how they feel about different locations or crowding together."

By varying the social circumstances in their fly experiments -- such as changing the ratio of male and female, or inducing hunger and thirst -- and monitoring the frustration values of the crowd, the researchers showed they can detect changes in the "mood" of the crowd. The DFT approach, therefore, not only predicts crowd behaviors under new circumstances, but also can be used to quickly and automatically detect changes in social behaviors.

Another application, using cell-phone and census data, could analyze political or economic drivers and population pressures to describe and predict large-scale population flows, such as mass migrations. "The resulting predictions of migration during acute events would enable better planning by all levels of government officials, from local municipalities to international bodies, with the potential to save millions of human lives," note the researchers.

Other contributors included J. Felipe Méndez-Valderrama, professor of physics, University of Los Andes, Bogota, Colombia; and Jeffrey Silver, senior analyst at Metron Inc.

Countries ranked by oil production emissions -- ScienceDaily

Until renewable sources of energy like wind or solar become more reliable and less expensive, people worldwide remain reliant on fossil fuels for transportation and energy. This means that if people want to reduce greenhouse gas emissions, there need to be better ways of mitigating the effects of extracting and burning oil and gas.

Now, Adam Brandt, assistant professor of energy resources engineering in the School of Earth, Energy & Environmental Sciences at Stanford, and his colleagues have performed a first global analysis comparing emissions associated with oil production techniques -- a step toward developing policies that could reduce those emissions. They published their work Aug. 30 in *Science*.

The group found that the burning of unwanted gas associated with oil production -- called flaring -- remains the most carbon-intensive part of producing oil. Brandt spoke with *Stanford Report* about the group's findings and strategies for reducing flaring.

What is flaring and why is it especially important to track?

Oil and gas are generally produced together. If there are nearby gas pipelines, then power plants, factories, businesses and homes can consume the gas. However, if you're very far offshore or can't get the gas to market, there's often no economically feasible outlet for the gas. In this case, companies want to get rid of the gas, so they often burn -- or flare -- it.

Thankfully, there is some value to the gas, so there can be some savings associated with stopping flaring. I think setting the expectation that the gas will be managed properly is the role of the regulatory environment. There are some efforts underway to try to tackle this -- the World Bank has a big effort called the Global Gas Flaring Reduction Partnership, where companies have

banded together to try to set flaring targets, so hopefully this will start to decline.

This work represents the first study breaking down oil-industry greenhouse gas emissions at the country level. What data did you look at to do this work?

This is the culmination of a larger project we've been working on for eight or so years. We used three different data sources. For some countries you can get data from governmental sources or regulatory agencies. Environmental agencies and natural resource agencies will also report information we can use. Otherwise, we go to petroleum engineering literature to get information about oil fields. Then we were able to collaborate with Aramco, an international oil company, to access a commercial data set. That allowed us to fill in gaps for a lot of smaller projects that are harder to get information on or the data gathering was just too intensive. With that, our paper covers about 98 percent of global oil supply. Necessarily, it's the first time we've been able to do this at this very resolved oil field-by-oil field level.

In mapping the world's oil supply, how did you estimate emissions from flaring on a country-by-country basis?

One of the challenges with flaring is that most countries don't report it. In many countries, we ended up using country-level average satellite data collected by the National Oceanic and Atmospheric Administration. Scientists there have developed ways to estimate the amount of gas flared using the brightness of the flare as seen from space. It's essentially an eye in the sky. For instance, Russia won't say how much they are flaring, but we can see it from the satellite.

Where have you seen flaring regulations work?

Offshore Canada has had a good success over the last 15 years. Basically, the rules there say that you're not allowed to flare above a certain amount. If flaring goes above a permitted level, Canada requires their offshore fields to shut down until they handle the gas. This can be done by reinjecting it back into the ground, converting it to liquefied natural gas or installing gas pipelines to get the gas to customers. Canadian flaring has dropped significantly, and these regulations prove that you can manage flaring and

require that people do something productive with the gas or put it back underground. Really, the challenge with flaring is there needs to be a policy or a regulatory apparatus to say, "Burning gas with no purpose isn't allowed; put it back in the ground or find something useful to do with it."

In the absence of federal action, how can we prioritize flaring reductions here in the U.S.?

If you don't see action at the U.S. federal level, you can work with leadership from state agencies. A good example of this was the state of North Dakota. North Dakota contains the Bakken Formation, which is one of the main regions for producing oil from hydraulically fractured wells. Five years ago, 30 percent of the gas being produced was being flared, and essentially the state government said this is not acceptable. Thirty percent was way too high and the gas had value -- it could be sold to cities like Chicago, Calgary or Denver. The government set a target for 10 percent, with the threat of potential production restrictions if producers didn't meet the target. So what happened? Producers in the region actually met the 10 percent target ahead of time. So I think things can keep moving forward. Obviously, it'd be better if we had some sort of federal action on this, but states can do a lot.

Who can drive the change needed across the globe?

Globally, I think international oil companies can really take the lead. A lot of the projects with flaring are in countries where environmental issues are poorly regulated. But many of these projects are developed by the local national oil company in cooperation with international partners. It's hard to wait on developing countries without large budgets or sophisticated regulatory capacity to put flaring rules into place. Instead of waiting for that to happen, we might expect the international oil companies work to solve the problems themselves by applying best practices from places were regulations have already solved the problem. For example, companies in Nigeria have increased gas reinjection and developed liquefied natural gas projects to get the gas to markets.

In the coming decades, we are going to be using a lot of oil and gas. It's inevitable. Taking best practices and applying them in places that are not as well regulated right now -- but hopefully will be -- can allow improvements

in one region to benefit another region.

Hopefully, we'll transition as quickly as possible to renewables, but while we use oil and gas in the meantime, let's do it responsibly.

The work was funded by the Natural Sciences and Engineering Research Council of Canada, Aramco Services Co., Ford Motor Co., the Carnegie Endowment for International Peace, the Hewlett Foundation, the ClimateWorks Foundation and the Alfred P. Sloan Foundation.

Dual-layer solar cell sets record for efficiently generating power -- ScienceDaily

Materials scientists from the UCLA Samueli School of Engineering have developed a highly efficient thin-film solar cell that generates more energy from sunlight than typical solar panels, thanks to its double-layer design.

The device is made by spraying a thin layer of perovskite -- an inexpensive compound of lead and iodine that has been shown to be very efficient at capturing energy from sunlight -- onto a commercially available solar cell. The solar cell that forms the bottom layer of the device is made of a compound of copper, indium, gallium and selenide, or CIGS.

The team's new cell converts 22.4 percent of the incoming energy from the sun, a record in power conversion efficiency for a perovskite-CIGS tandem solar cell. The performance was confirmed in independent tests at the U.S. Department of Energy's National Renewable Energy Laboratory. (The previous record, set in 2015 by a group at IBM's Thomas J. Watson Research Center, was 10.9 percent.) The UCLA device's efficiency rate is similar to that of the poly-silicon solar cells that currently dominate the photovoltaics market.

The research, which was published today in *Science*, was led by Yang Yang, UCLA's Carol and Lawrence E. Tannas Jr. Professor of Materials Science.

"With our tandem solar cell design, we're drawing energy from two distinct parts of the solar spectrum over the same device area," Yang said. "This increases the amount of energy generated from sunlight compared to the CIGS layer alone."

Yang added that the technique of spraying on a layer of perovskite could be easily and inexpensively incorporated into existing solar-cell manufacturing processes.

The cell's CIGS base layer, which is about 2 microns (or two-thousandths of a millimeter) thick, absorbs sunlight and generates energy at a rate of 18.7 percent efficiency on its own, but adding the 1 micron-thick perovskite layer improves its efficiency -- much like how adding a turbocharger to a car engine can improve its performance. The two layers are joined by a nanoscale interface that the UCLA researchers designed; the interface helps give the device higher voltage, which increases the amount of power it can export.

And the entire assembly sits on a glass substrate that's about 2 millimeters thick.

"Our technology boosted the existing CIGS solar cell performance by nearly 20 percent from its original performance," Yang said. "That means a 20 percent reduction in energy costs."

He added that devices using the two-layer design could eventually approach 30 percent power conversion efficiency. That will be the research group's next goal.

The study's lead authors are Qifeng Han, a visiting research associate in Yang's laboratory, and Yao-Tsung Hsieh and Lei Meng, who both recently earned their doctorates at UCLA. The study's other authors are members of Yang's research group and researchers from Solar Frontier Corp.'s Atsugi Research Center in Japan.

The research was supported by the National Science Foundation and the Air Force Office of Scientific Research. Yang and his research group have been working on tandem solar cells for several years and their accomplishments include developing transparent tandem solar cells that could be used in windows.

Story Source:

Materials provided by **UCLA Samueli School of Engineering**. *Note: Content may be edited for style and length.*

Scientists predict superelastic properties in a group of iron-based superconductors -- ScienceDaily

A collaboration between scientists at the U.S. Department of Energy's Ames Laboratory and the Institute for Theoretical Physics at Goethe University Frankfurt am Main has computationally predicted a number of unique properties in a group of iron-based superconductors, including room-temperature super-elasticity.

Ames Laboratory produced samples of one of these iron arsenide materials with calcium and potassium, $CaKFe_4As_4$, and experimentally discovered that when placed under pressure, the structure of the material collapsed noticeably.

"It's a large change in dimension for a non-rubber-like material, and we wanted to know how exactly that collapsed state was occurring," said Paul Canfield, a senior scientist at Ames Laboratory and a Distinguished Professor and the Robert Allen Wright Professor of Physics and Astronomy at Iowa State University.

Through computational pressure simulations, the researchers learned that the material collapsed in stages -- termed "half-collapsed tetragonal phases" -- with the atomic structure near the calcium layers in the materials collapsing first, followed by the potassium layer collapsing at higher pressures. The simulations also predicted these behaviors could be found in similar materials that are as-yet untested experimentally.

"Not only does this study have implications for properties of magnetism and superconductivity, it may have much wider application in room-temperature elasticity," said Canfield.

Canfield collaborated with Roser Valenti at the Institute for Theoretical

Physics at Goethe University Frankfurt am Main, who served as the host faculty member for Canfield's Humboldt Award in 2014.

It has been a delight as an experimentalist to be able to access this theoretical group's ever-increasing computational skills to model and predict properties," said Canfield.

Story Source:

Materials provided by **DOE/Ames Laboratory**. *Note: Content may be edited for style and length.*

Injection wells can induce earthquakes miles away from the well: Study finds injecting fluid into sedimentary rock can produce bigger, more distant earthquakes than injecting into the underlying basement rock -- ScienceDaily

A study of earthquakes induced by injecting fluids deep underground has revealed surprising patterns, suggesting that current recommendations for hydraulic fracturing, wastewater disposal, and geothermal wells may need to be revised.

Researchers at UC Santa Cruz compiled and analyzed data from around the world for earthquakes clearly associated with injection wells. They found that a single injection well can cause earthquakes at distances more than 6 miles (10 kilometers) from the well. They also found that, in general, injecting fluids into sedimentary rock can cause larger, more distant earthquakes than injecting into the underlying basement rock.

"This is problematic, since the current advice is to preferentially inject into the sedimentary sequence as a theoretically safer alternative to the basement rock," said Emily Brodsky, professor of Earth and planetary sciences at UC Santa Cruz.

Postdoctoral researcher Thomas Goebel said the key issue is the spatial footprint of induced seismicity around the injection well. "It's not that the basement rock is safe, because there is still the possibility of encountering a fault in the basement rock that can cause a large earthquake, but the probability is reduced because the spatial footprint is smaller," he said.

In a paper published August 31 in *Science*, Goebel and Brodsky described

two distinct patterns of induced seismicity, which they associated with different physical mechanisms acting in basement rock and sedimentary rock. In the first pattern, associated with injection into basement rock, earthquakes tend to occur in a compact cluster around the well, with a steep decline in earthquakes farther from the well. In the other pattern, associated with sedimentary rock, induced earthquakes decline gradually with distance from the well and occur at much greater distances.

The physical mechanism by which injection wells induce earthquakes was thought to be a direct result of increased fluid pressure in the pores of the rock, causing faults to slip more easily. This mechanism can account for the spatial pattern of seismicity seen with injection into basement rock, Goebel said. But the pattern seen with injection into sedimentary rock suggests a different mechanism resulting from efficient "poroelastic coupling," which controls the ability of the rock to transmit fluid stresses into the solid rock matrix.

"When you inject water into the ground, it pushes on the surrounding rock and creates elastic stress in the rock, which can put pressure on faults at a distance without putting water into those faults. So if poroelasticity is dominant, you end up with a larger footprint because it's loading neighboring faults beyond the area of increased pore pressure," Brodsky said.

According to Goebel, the crystalline basement rock is stiffer and has lower porosity than sedimentary rock. "Therefore, the increase in pore pressure is limited to isolated pockets around the well, and the coupling of that with the overall stress field is low," he said.

Goebel said their findings help explain the extent of induced seismicity in regions such as Oklahoma where there are many injection sites in oil and gas fields. Oklahoma has seen a dramatic surge in earthquakes since 2010, to the extent that there are now more earthquakes each year in Oklahoma than in California. Goebel and Brodsky did not include sites in Oklahoma in their study, however, because there are so many injection wells they couldn't isolate the effects of individual wells.

"In Oklahoma, they are injecting into the high-porosity sedimentary unit above the basement, but these elastic stresses can be transmitted over a large

distance, so you could activate a large basement fault at a distance of 10 kilometers," Goebel said. "That may be what we're seeing in places like Oklahoma."

Story Source:

Materials provided by **University of California - Santa Cruz**. Original written by Tim Stephens. *Note: Content may be edited for style and length.*

DNA accessibility, gene expression jointly profiled in thousands of cells: New assay advances research on how various cells types interpret their genetic code -- ScienceDaily

Scientists have now developed an assay that concurrently profiles both the epigenome and transcriptome of each of thousands of single cells.

The epigenome and transcriptome are part of the molecular biology that converts a genetic blueprint into tools and materials for living cells.

The genomes of different types of cells may be identical, while their epigenomes and transcriptomes are not. The epigenome consists of a set of marks that shape what each cell's genome will do, while the transcriptome is the set of copies of the instructions themselves. These encode the production of proteins. The flow of information from the inherited plan to the making of proteins is critical for forming and maintaining life.

Cells can access only certain portions of their chromatin-packaged, double-stranded genome during RNA transcription. Because this access varies among different cell types, chromatin accessibility is what helps determine the shape, function and variety of the diverse cells in a multi-cellular, living organism.

The researchers call their assay sci-CAR. Sci stands for single-cell combinatorial indexing, a means of studying large numbers of single cells at once. In a research report Aug. 30 in *Science*, the scientists describe how the new assay merges two other genomic assays into one protocol.

These assays, among their other features, incorporate unique barcodes for the nucleic acid contents of cells or of the cell nucleus, which contains the main

control center for living cells. The scientists' method for labeling and sorting cells lets them link the messenger RNA and chromatin accessibility profiles of individual cells.

Most assays of what goes on genetically inside single cells, the scientists noted, can survey only one aspect of cellular biology. The ability to investigate several classes of molecules concurrently could uncover, for example, how certain genetic mechanisms are related and regulated.

It could also improve the usefulness of cell atlases of complex organisms, like those of the worm or mouse. Eventually, it could be helpful in compiling a human cell atlas.

The new method was developed by scientists at the Brotman Baty Institute for Precision Medicine in Seattle, University of Washington School of Medicine Department of Genome Sciences, Oregon Health Sciences University, Illumina, Inc., in California, Allen Discovery Center for Cell Lineage Tracing, and Howard Hughes Medical Institute.

The first author of the study is Junyue Cao, a graduate student in the Molecular and Cellular Biology program and in genome sciences at the University of Washington School of Medicine. The study was led by Jay Shendure and Cole Trapnell. Both are faculty in the Department of Genome Sciences at the UW School of Medicine and investigators at the Brotman Baty Institute, where Shendure is the director.

The researchers first tried their co-assay on more than 4,800 cells in a lung-cancer-derived cell culture model of cortisol response. In this model, the cells are treated with the corticosteroid dexamethasone. This synthetic steroid can activate the binding of thousands of locations on the genome and change the expression of hundreds of genes.

The scientists then examined the time course of dexamethasone's effects on gene expression, as well as dynamic changes that occurred in chromatin accessibility in the same cells.

In related work, the researchers sought to study the gene-control landscape that underlies the messenger RNA collections found in the different types of

cells in the mammalian kidney.

In applying their co-assay to the nuclei from whole mouse kidneys, they recovered both transcriptome and chromatin accessibility profiles from 11,296 cells. They clustered their mouse kidney cells into 14 groups, and characterized cell-type specific epigenome landscapes and linked transcriptome features.

Based on the covariance between epigenome and transcriptome, the researchers also learned that they could draw links between distant genomic regulatory elements and their targeted genes to explain some of the differences in gene expression across various cell types.

Looking forward, there are clear advantages of a joint assay over assays that only profile either RNA transcription or DNA accessibility. One advantage of sci-CAR specifically is that this method could potentially be used to jointly assay millions of single cells at once.

Among its limitations is the sparseness of some of the chromatin accessibility data. The researchers suggested that this might be overcome in future experiments by optimizing some aspects of the current protocol.

The researchers hope to continue to combine additional co-assays so that molecular biologists could concurrently trace the flow of genetic information from DNA to RNA to specific proteins in each of the many single cells that can exist in complex living things.

Researchers are turning to deadly venoms in their quests for life-saving therapies -- ScienceDaily

Venomous reptiles, bugs and marine life have notorious reputations as dangerous, sometimes life-threatening creatures. But in a paper in the current issue of *Science*, first author Mandë Holford, an associate professor of chemistry and biochemistry at The Graduate Center of The City University of New York (GC/CUNY) and Hunter College, details how technology and a growing understanding of the evolution of venoms are pointing the way toward entirely new classes of drugs capable of treating diabetes, autoimmune diseases, chronic pain, and other conditions.

According to Holford and her colleagues, venomous species account for more than 15 percent of the Earth's documented biodiversity, and they can be found in virtually all marine and terrestrial habitats. Still, researchers have studied very few venoms because until recently they lacked the appropriate technology for analyzing the tiny amounts of venom that can be extracted from these mostly small species. But innovations in omics (technologies that map the roles, relationships, and actions of an organism's molecular structure) are allowing researchers to uncover evolutionary changes and diversification among specific venomous species that could prove useful in developing new drugs capable of precisely targeting and binding to molecules that are active in certain human diseases.

"Knowing more about the evolutionary history of venomous species can help us make more targeted decisions about the potential use of venom compounds in treating illnesses," said Holford. "New environments, the development of venom resistance in its prey, and other factors can cause a species to evolve in order to survive. These changes can produce novel compounds -- some of which may prove extremely useful in drug development."

To date, only six Food and Drug Administration-approved, venom-derived drugs have been developed as a result of modern-day research, but Holford and her colleagues believe greater investment in venom research could yield therapies for currently untreatable diseases as well as improved therapeutic options.

Potential drug advances include therapeutic peptides derived from the venomous sea anemone, which researchers believe could treat autoimmune diseases; therapeutic neurotoxins derived from the Conus magus, which scientists think could provide non-addictive treatment of chronic pain; chlorotoxin from the deathstalker scorpion, which could be the basis for a surgical tumor-imaging technique; and spider toxins, which could yield ecofriendly insecticides.

Holford and her follow authors conclude that an evolution-informed perspective will help focus venom research so that it can leverage the extraordinary biochemical warfare created by nature to yield transformative therapeutics and bio-insecticides.

Story Source:

Materials provided by **Advanced Science Research Center, GC/CUNY**.
Note: Content may be edited for style and length.

Pushing big data to rapidly advance patient care: Technology offers a solution for moving research out of journals and into the clinic faster -- ScienceDaily

The breakneck pace of biomedical discovery is outstripping clinicians' ability to incorporate this new knowledge into practice.

Charles Friedman, Ph.D. and his colleagues recently wrote an article in the *Journal of General Internal Medicine* about a possible way to approach this problem, one that will accelerate the movement of newly-generated evidence about the management of health and disease into practice that improves the health of patients.

Traditionally, it has taken many years, and even decades, for the knowledge produced from studies to change medical practice. For example, the authors note in the article, the use of clot-busting drugs for the treatment of heart attacks was delayed by as much as 20 years because of this inability to quickly incorporate new evidence.

"There are lots of reasons why new knowledge isn't being rapidly incorporated into practice," says Friedman. "If you have to read it in a journal, understand it, figure out what to do based on it, and fit that process into your busy day and complicated work flow, for a lot of practitioners, there's just not enough room for this."

Informing medical practice

Much of the generation of new evidence is done by groups like the federal Agency for Healthcare Quality and Research and the Cochrane Collaboration, a UK-based non-profit group designed to organize medical research into systematic reviews and meta analyses. These reviews synthesize all of the available medical research about a given topic with the hope of informing

medical practice. However, that movement of this accumulated knowledge to medical practice can happen incredibly slowly, if at all.

The new article focuses on the need to harness the power of technology to enable health systems to analyze the data they generate during the process of taking care of patients to generate new "local" evidence and use this in combination with published reviewed evidence to improve health outcomes.

The key to using both types of evidence, they argue, is transforming human readable knowledge -- the words, tables and figures in a typical journal article -- into computable forms of that same knowledge.

"A lot of scientific studies result in some kind of model: an equation, a guideline, a statistical relationship, or an algorithm. All of these kinds of models can be expressed as computer code that can automatically generate advice about a specific patient," Friedman explains. When both "local" models and published models are available in computable forms, it is suddenly possible to generate advice that reflects both kinds of sources.

Computable forms are key

He notes that while Michigan Medicine, along with most other health systems that use electronic health records, is using its data to continuously improve quality of care, putting this knowledge in computable forms creates many new ways to apply that knowledge to improve care.

The University of Michigan Medical School's Department of Learning Health Sciences is taking the lead in transforming biomedical knowledge into computable forms that are open and accessible to anyone. They've created a computer platform called the Knowledge Grid, that stores computable knowledge in digital libraries and then uses that knowledge to generate patient-specific advice.

"The value of Big Data is to generate Big Knowledge," says Friedman. "The power of Big Data is to provide better models. If all those models do is sit in journal articles, no one's going to be any healthier."

https://www.sciencedaily.com/releases/2018/08/180830143050.htm

Information technology jobs outpace most other jobs in productivity and growth since 2004 -- ScienceDaily

Jobs in information technology-like computer software, big data, and cybersecurity-are providing American workers with long-lasting financial stability, suggests a new study from the University of British Columbia and the Massachusetts Institute of Technology.

"The future of jobs is in IT, and IT-intensive tasks" said Giovanni Gallipoli, co-author and associate professor from the Vancouver School of Economics at UBC. "Growth and productivity in jobs involving IT tasks are very strong, and workers who can perform such tasks have a clear competitive advantage in the labour market."

The study reveals the well documented slow-down in employment and wage gains associated with skills and education that has been recorded after the year 2000 is in fact not occurring at all for jobs that involve IT. The share of these jobs has increased substantially over the past two decades, with IT-intensive occupations growing by 19.5 per cent between 2004 and 2017. Less IT-intensive occupations only grew by 2.4 per cent over the same period. The growth in IT jobs is more than eight times the growth rate than for other jobs over the past decade.

"While there is clear evidence that earnings growth for Americans with college degrees has somewhat flattened since 2000, earnings have actually grown significantly for individuals working in jobs involving IT tasks," said Gallipoli. "Both companies and workers stand to benefit if they invest in IT education."

Despite the decline in traditional manufacturing jobs from automation or off-shoring, the study also shows that a subset of jobs in manufacturing that involve IT tasks have increased in number, as well as having high

productivity growth and returns.

According to the researchers, the rise of IT has changed the nature of employment in the manufacturing sector, creating a greater demand for workers with computing and technical expertise.

"Companies often report troubles finding enough workers for IT-intensive tasks," said MIT's Christos Makridis, the study's co-author. "This suggests the presence of a skills gap for jobs with digital and technical requirements. The insufficient number of job candidates able to perform complex IT tasks suggests the possibility of workers' mismatches in the labour market. It also suggests the need for additional training, whether formal or on the job, like apprenticeships, that focuses on the skills that are most in demand."

While much of the debate around automation and the role of technology in employment today focuses on its impact on jobs, or how workers stand to be replaced by robots, the researchers stress greater focus needs to be paid to its effects on productivity, wages and the ongoing structural change in the labour market of both manufacturing and services.

"Our research starts to highlight these sizable effects, and the growth in employment demand for certain IT-intensive tasks cannot be easily automated or offshored," Gallipoli said. "The emergence of IT intensive jobs has had a major impact on the structure and on the distribution of wages both within and across sectors."

"As the cost of collecting and processing information continues declining, every company is going to turn into a data science company, whether they like it or not," said Makridis. "That is only going to raise the demand for information technology workers."

The study, Structural Transformation and the Rise of Information Technology, is published in the *Journal of Monetary Economics*.

Story Source:

Materials provided by **University of British Columbia**. *Note: Content may be edited for style and length.*

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Catalyst advance could lead to economical fuel cells -- ScienceDaily

Researchers at Washington State University have developed a new way to make low-cost, single-atom catalysts for fuel cells -- an advance that could make important clean energy technology more economically viable.

Their work is published in the *Advanced Energy Materials* journal.

Hydrogen fuel cells are critical for the clean energy economy as they are more than two times as efficient at creating electricity than polluting combustion engines. Their only waste product is water.

However, the high price of the platinum-based catalysts that are used for the chemical reaction in fuel cells significantly hinders their commercialization.

Instead of the rare platinum, researchers would like to use nonprecious metals, such as iron or cobalt. But reactions with these abundantly available metals tend to stop working after a short time.

"Low-cost catalysts with high activity and stability are critical for the commercialization of the fuel cells." said Qiurong Shi, postdoctoral researcher in the School of Mechanical and Materials Engineering (MME) and a co-first author on the paper.

Recently, researchers have developed single-atom catalysts that work as well in the laboratory setting as using precious metals. The researchers have been able to improve the stability and activity of the nonprecious metals by working with them at the nanoscale as single-atom catalysts.

In this new work, the WSU research team, led by Yuehe Lin, an MME professor, used iron or cobalt salts and the small molecule glucosamine as precursors in a straightforward high temperature process to create the single-atom catalysts. The process can significantly lower the cost of the catalysts

and could be easily scaled up for production.

The iron-carbon catalysts they developed were more stable than commercial platinum catalysts. They also maintained good activity and didn't become contaminated, which is often a problem with common metals.

"This process has many advantages," said Chengzhou Zhu, a first author on the paper who developed the high temperature process. "It makes large-scale production feasible, and it allows us to increase the number and boost the reactivity of active sites on the catalyst."

Lin's group collaborated on the project with Scott Beckman, an MME associate professor at WSU, as well as with researchers at Advanced Photon Source at Argonne National Laboratory and Brookhaven National Laboratory for materials characterization.

"The advanced materials characterization user facility at the national laboratories revealed the single-atom sites and active moieties of the catalysts, which led to the better design of the catalysts," said Lin.

Story Source:

Materials provided by **Washington State University**. *Note: Content may be edited for style and length.*

Solar eruptions may not have slinky-like shapes after all -- ScienceDaily

As the saying goes, everything old is new again. While the common phrase often refers to fashion, design, or technology, scientists at the University of New Hampshire have found there is some truth to this mantra even when it comes to research. Revisiting some older data, the researchers discovered new information about the shape of coronal mass ejections (CMEs) -- large-scale eruptions of plasma and magnetic field from the sun -- that could one day help protect satellites in space as well as the electrical grid on Earth.

"Since the late 1970s, coronal mass ejections have been assumed to resemble a large Slinky -- one of those spring toys -- with both ends anchored at the sun, even when they reach Earth about one to three days after they erupt," said Noe Lugaz, research associate professor in the UNH Space Science Center. "But our research suggests their shapes are possibly different."

Knowing the shape and size of CMEs is important because it can help better forecast when and how they will impact Earth. While they are one of the main sources for creating beautiful and intense auroras, like the Northern and Southern Lights, they can also damage satellites, disrupt radio communications and wreak havoc on the electrical transmission system causing massive and long-lasting power outages. Right now, only single point measurements exist for CMEs making it hard for scientists to judge their shapes. But these measurements have been helpful to space forecasters, allowing them a 30 to 60 minute warning before impact. The goal is to lengthen that notice time to hours -- ideally 24 hours -- to make more informed decisions on whether to power down satellites or the grid.

In their study, published in *Astrophysical Journal Letters*, the researchers took a closer look at data from two NASA spacecraft, Wind and ACE, typically orbiting upstream of Earth. They analyzed the data of 21 CMEs over a two-year period between 2000 and 2002 when Wind had separated from ACE. Wind had only separated one percent of one astronomical unit

(AU), which is the distance from the sun to the Earth (93,000,000 miles). So, instead of now being in front of Earth, with ACE, Wind was now perpendicular to the Sun-Earth line, or on the side.

"Because they are usually so close to one another, very few people compare the data from both Wind and ACE," said Lugaz. "But 15 years ago, they were apart and in the right place for us to go back and notice the difference in measurements, and the differences became larger with increasing separations, making us question the Slinky shape."

The data points toward a few other shape possibilities: CMEs are not simple Slinky shapes (they might be deformed ones or something else entirely), or CMEs are Slinky-shaped but on a much smaller scale (roughly four times smaller) than previously thought.

While the researchers say more studies are needed, Lugaz says this information could be important for future space weather forecasting. With other missions being considered by NASA and NOAA, the researchers say this study shows that future spacecraft may first need to investigate how close to the Sun-Earth line they have to remain to make helpful and more advanced forecast predictions.

This research was supported by NASA and the National Science Foundation.

Story Source:

Materials provided by **University of New Hampshire**. *Note: Content may be edited for style and length.*

Nonlinear ghost imaging: Research could lead to better security scanners -- ScienceDaily

Using a single pixel camera and terahertz electromagnetic waves, a team of physicists at the University of Sussex has devised a blueprint that could lead to the development of better airport scanners capable of detecting explosives.

Miss Luana Olivieri, PhD student and Dr Juan Sebastian Totero Gongora, a Research Fellow in Experimental Photonics of the Emergent Photonics Lab directed by Professor Marco Peccianti and Dr Alessia Pasquazi, have found an innovative way to capture with high accuracy, not just the shape of an object, but also its chemical composition using a special "single point" camera capable of operating at terahertz (THz) frequencies.

Although their work is mostly theoretical at this stage -- they introduced a novel imaging concept named nonlinear ghost imaging -- their ability to capture a more detailed image to previous studies has landed them on the front page of the scientific journal *ACS Photonics*.

Dr Juan Sebastian Totero Gongora said: "Our approach produces a new type of image which is quite different from what you would get from a standard single-pixel camera as it provides much more information on the object. Compared to prior single pixel images, we also demonstrated that our resolution is inherently higher."

Lying between microwaves and infrared in the electromagnetic spectrum, terahertz radiation has a much larger wavelength to visible light. It can easily penetrate several common materials like paper, clothes and plastics leading to the development of technology within security scanning and manufacture control which allows people to see inside objects and wrapping.

The radiation provokes a different response from biological samples though,

allowing researchers to classify materials which are almost indistinguishable with visible light.

Scientists believe that THz waves could have enormous potential in developing critical applications such as explosives detection, medical diagnostics, quality control in manufacturing and food safety.

The challenge, however, lies in the development of reliable and cost-effective cameras as well as the ability to identify objects smaller than the wavelength.

But, by taking a different approach to previous studies in this field, the team of the Emergent Photonics Lab may have found a way to overcome these limitations.

While previous research has illuminated objects with many patterns of laser light in just one colour to extract an image, the researchers illuminated an object with patterns of THz light which contain a broad spectrum of colours.

A single pixel camera (rather than a standard one containing multiple pixels as sold on the high street) can capture the light reflected by the object for each pattern. In the team's study, they found that the camera can detect how the pulse of light is altered in time by the object (even if the THz pulse is an extremely short event). By combining this information with the known shape of the patterns, the shape of the object and its nature are revealed.

The technique may recall the way the brain develops understanding in the vision by focusing separately on different elements and then fusing the relevant information.

Professor Marco Peccianti added: "This is a really significant development and we're really happy that *ACS Photonics* decided to lead with our research on their front cover. Previous approaches to THz single-pixel cameras cannot preserve the complete information on an object but we understood where the issue lay and identified a way to extract a more complete image.

"We hope that a similar system to ours could be used in real-life applications in biology, medicine and security to determine the chemical composition of an object and its spatial distribution in just one step."

The team's findings are a considerable improvement on established technologies and could have a huge impact beyond the field of THz cameras.

For instance, their technique could be used to design high-resolution cameras in other frequency ranges which could then become part of technology for collision sensors, body scanner or ultra-rapid radars for self-driving cars.

The researchers are now following up on their research, which is largely based on simulations, to experimentally demonstrate their device.

Story Source:

Materials provided by **University of Sussex**. Original written by Stephanie Allen. *Note: Content may be edited for style and length.*

New method for hydroboration of alkynes: Radicals induce unusual selectivity -- ScienceDaily

Organoboron compounds have been widely used to create new organic molecules since Prof. Suzuki, a 2010 Nobel Prize winner in chemistry, developed palladium-catalyzed cross coupling reactions with organoboron compounds (Suzuki coupling). In addition, many boron-containing compounds themselves are promising materials. They can be used as medicines and organic electro-luminescence materials because of boron's unique electronic nature.

Borane (BH_3) and its derivatives stabilized by ligands are the simplest boron compounds. They can react with a carbon–carbon triple bond (alkyne, C≡C) to yield an insertion product (H–C=C–BH_2). This reaction, called hydroboration, is a powerful method to prepare organoboron compounds. However, the reaction typically provides only a cis-product, which means that H and BH_2 are introduced on the same side of the triple bond. That is, it is difficult to synthesize a trans-hydroboration product with the opposite geometric configuration. Previously, there have been very limited examples of trans-hydroboration of alkynes.

The collaboration team between Kanazawa University and the University of Pittsburgh succeeded in the development of trans-hydroboration reactions of alkynes based on radical chemistry. The team employed N-heterocyclic carbene boranes (NHC-boranes) to combine hydroboration with radical chemistry. NHC-boranes can be handled easily because of their stability, and they are good precursors of boryl radicals (boron-centered radicals). Indeed, an NHC-boryl radical can be readily formed by simple thermolysis in the presence of inexpensive commercial di-tert-butyl peroxide. The radical can add to an alkyne to form a carbon?boron (C?B) bond and a new carbon radical. Trans-selectivity in hydroboration is kinetically induced when the highly reactive carbon radical captures a hydrogen atom from the starting

NHC-borane. As a result, the overall process establishes a radical chain cycle. This mechanism is quite different from that of known hydroboration reactions.

From easily available alkynes, the present protocol provides various bench-stable alkenyl borane compounds that are not easily accessible by known methods. Some of them can be converted to retinoid mimics, which are drug candidates, by modified Suzuki coupling**.**

Organoboron compounds synthesized by the present method will give access to new boron-containing π-systems by further chemical transformation. Therefore, this type of trans-hydroboration reaction will facilitate advances in medicinal chemistry and materials science. From the standpoint of pure chemistry, this study expands the potential of radicals in synthetic chemistry. In short, we illustrate that radicals are capable of controlling chemical reactions precisely despite their extreme reactivity.

Dennis Curran (University of Pittsburgh), a collaborator in this study, comments, "It has been a pleasure to be involved in this collaboration, which was led by the Kanazawa team. The new reaction that we have discovered is unique, and I am excited about its prospects for extension in the directions of both basic research and practical applications."

Story Source:

Materials provided by **Kanazawa University**. *Note: Content may be edited for style and length.*

Introducing high-performance non-fullerene organic solar cells -- ScienceDaily

Organic solar cells (OSCs) has driven their efficiencies to above 10% to reach a viable level for commercialization. However, the increase in the photoactive layer thickness has resulted in lower efficiency levels, which therefore brings much complex manufacturing process.

A research team, led by Professor Changduk Yang and his research team in the School of Energy and Chemical Engineering at UNIST, has introduced a novel method that can solve issues associated with the thickness of the photoactive layers in OSCs.

In the study, the research team has succeeded in obtaining an efficiency of 12.01% in the organic solar cells, using a non-fullerance acceptor (IDIC) in the photoactive layer. Moreover, the new photoactive layer maintained its initial efficiency, even when the maximum measured thickness being in the range of 300 nm. This will help accelerate the design process, as well as the further commercialization of OSCs.

"Photoactive layers in the existing OSCs are rather thin (100 nm), and therefore it has been impossible to handle them via large-area printing process," says Professor Yang. "The new photoactive layer maintained its initial efficiency, even when the maximum measured thickness being in the range of 300 nm."

Conventional solar cells are inorganic solar cells that are made of silicon (Si) semiconductors. While these solar cells are highly efficient and stable, they are inflexible and expensive, thus challenging to produce. Therefore, in recent years, lightweight organic solar cells (OSCs) and perovskite solar cells have gained much attention as the promising candidates for next-generation solar cells.

Although OSCs do exhibit high stability and reproducibility, the efficiency

level of OSCs is not nearly as high as that of the perovskite solar cells. In the study, Professor Yang has solved the issues associated with the thickness of the photoactive layers in OSCs, thereby taking a step closer to the realization of large-area printing process.

Photoactive layers used in solar cells convert solar energy into electrical energy. When these layers are exposed to sunlight, the excited electrons escape from the atom and generate free electrons and holes in a semiconductor. Here, the electrical energy is supplied by the movement of electrons and holes. The transfer of electrons is referred to as 'Channel I', while the movement of holes refers to as 'Channel II'.

"Fullerene-based solar cells utilize only 'Channel I due to inefficient light absorption in the thin active layers," says Sang Myeon Lee in the Combined M.S./Ph.D. program in the School of Energy and Chemical Engineering at UNIST, the first author of the study. "New solar cells are capable of utilizing both Channel I and Channel II, thereby realizing high efficiency level of 12.01%."

"This study highlights the importance of optimizing the trade-off between charge separation/transport and domain size to achieve high-performance NF-PSCs," says Professor Yang. "We will contribute to the production and commercialization of high efficiency organic solar cells in the future."

"Our study presents a new pathway for the synthesis of non-fullerene photoactive materials," says Professor Yang. "We hope to further contribute to the production and commercialization of high-efficient OSCs cell."

Genetically encoded sensor tracks changes in oxygen levels with very high sensitivity -- ScienceDaily

Oxygen is a major player in the biochemical processes that make life on earth possible. Being able to rapidly and accurately measure oxygen levels inside living cells could be useful in several areas of biology, including physiology, medicine, and bioengineering. For example, oxygen levels in cancer cells can affect their response to anti-cancer therapies, while oxygen levels in tissues following a stroke or heart attack can influence treatment and recovery. In a recently published article in the journal *Scientific Reports*, Jiro Nomata and Toru Hisabori, researchers at Tokyo Institute of Technology, report the development of a new type of oxygen sensor that may dramatically alter our ability to detect changes in cellular oxygen levels. "Limitations in previously developed methods to measure oxygen levels make it difficult to analyze oxygen levels in living cells" notes Prof Hisabori, "so we aimed to overcome these limitations by developing a genetically encoded sensor that can provide real-time information on the dynamic changes of oxygen levels in living cells."

The researchers used a protein called the direct oxygen sensor protein, or DosP, from the bacterium *E. coli*, which has the ability to either bind or release oxygen depending on the oxygen levels inside the cell. The part of the protein that can bind oxygen was isolated and linked to a fluorescent protein, before evaluating the fluorescence intensity of the resulting product under different oxygen levels. The researchers found that the fluorescence of their novel protein, named ANA sensor (*an*aerobic/*a*erobic sensing fluorescence protein), increased in the presence of oxygen and decreased in the absence of oxygen, thereby successfully tracking the dynamic changes in oxygen content. Further development allowed them to fine-tune the protein to enable more accurate quantification of oxygen levels. By using the ANA sensor, photosynthetic oxygen production by a photosynthetic microorganism (cyanobacteria) could be monitored. Notably, in a dramatic improvement

over previous oxygen detection methods, changes in oxygen levels are reflected by changes in ANA sensor fluorescence with very high sensitivity.

Perhaps the most significant aspect of this study, however, is the potential to apply this method to the development of other protein sensor probes to detect a number of cellular changes at the molecular level. "Almost all current sensor protein probes are based on conformational changes," notes Dr. Nomata. "In contrast, the fluorescence quenching mechanism used in this study expands the possibilities for the development of novel protein sensor probes."

Story Source:

Materials provided by **Tokyo Institute of Technology**. *Note: Content may be edited for style and length.*

Friction loss at first contact: The material does not forgive: Materials researchers study the causes of wear -- ScienceDaily

Wear has major impacts on economic efficiency or health. All movable parts are affected, examples being the bearing of a wind power plant or an artificial hip joint. However, the exact cause of wear is still unclear. Scientists of Karlsruhe Institute of Technology (KIT) recently proved that the effect occurs at the first contact already and always takes place at the same point of the material. Their findings help develop optimized materials and reduce consumption of energy and raw materials.

The researchers present results of two studies in the *Scripta Materialia*.

Friction occurs wherever objects adhere to each other or have sliding or rolling contact. Friction forces cause wear which results in enormous costs. About 30% of the energy consumed in the transportation sector is used to overcome friction. In Germany, friction and wear produce costs corresponding to about 1.2 to 1.7% of the gross domestic product, i.e. between 42.5 and 55.5 billion euros in 2017. It is well known that when rubbing hands friction makes the hands get warmer. Reaction of materials to friction is far more complicated.

"Here, many things change at the same time. But how exactly this process starts, where wear particles are formed, and what effect friction energy has is hardly understood, as it has been impossible so far to look directly below the surface of the friction partners," says Professor Peter Gumbsch, holder of KIT's Chair for Mechanics of Materials and Head of the Fraunhofer Institute for Mechanics of Materials. "With our new microscopic methods, however, we can do so. They reveal a sharp interface in the material, at which the wear particles are detached. We want to find the cause of this material weakness."

In their experiments, the scientists always detected a sharp line at a depth of

150 to 200 nm. It forms at first contact already and is irreversible. It is the source of the later weakness in the material. The scientists tested various materials, such as copper, various brass alloys, nickel, iron or tungsten and always obtained the same result.

"These results are entirely new. We did not expect them," Gumbsch says. The findings contribute to understanding and reproducing processes that take place on the molecular level during friction. "As soon as we understand the effects occurring, we can interfere specifically. It is my objective to develop guidelines for the future production of alloys or materials with better friction properties," Gumbsch adds.

A Wave Forms

The defect in the material is a so-called dislocation. Dislocations are responsible for plastic, i.e. irreversible, deformations. Dislocations result when atoms shift relative to each other. As a result, an atomic wave propagates in the material, similar to the movement of a snake. "We found that these dislocations during friction form the line-shaped structure observed in a self-organized manner. This effect occurred in every experiment," explains Dr. Christian Greiner of KIT's Institute for Applied Materials - Computational Materials Science (IAM-CMS).

The scientists compared the effect observed with the mechanical stress distribution in the material that can be calculated analytically. Calculations confirmed that certain dislocation types self-organize in a stress field at a depth between 100 and 200 nm.

Quicker Oxidation by Friction

In addition to the effect mentioned, scientists used copper samples to study the effect of friction on oxidation of surfaces. After a few friction cycles, copper oxide spots formed on the surface. In the course of time, they grew to semi-circular nanocrystalline copper oxide clusters. The copper-2-oxide nanocrystals of 3 - 5 nm in size were surrounded by an amorphous structure. They increasingly grew into the material until they overlapped and formed a closed oxide layer. According to Greiner, this phenomenon has been known for a long time, but the cause of this effect is still unknown. "It is very

important to understand how friction-caused oxidation takes place. In materials science, copper is used rather frequently. And copper also is an important material for movable parts," Greiner says. Many bearings consist of copper alloys, such as bronze or brass. Consequently, the study results are of considerable interest to copper processing industries.

Hard Ball Meets Soft Copper

The approach used for both studies is rather simple: a sapphire ball is moved in a very smooth, slow, and controlled way straight across a plate made of pure copper. The sapphire ball was chosen, as it always guarantees the same, reproducible contact and friction of the ball itself can be neglected due to the hardness of sapphire. After every movement across the plate, the researchers measured the deformation caused and the resulting structural modifications inside the metals. In their unique approach, they combined friction experiments with non-destructive testing methods, data science algorithms, and high-resolution electron microscopy.

Artificial intelligence guides rapid data-driven exploration of underwater habitats: Mapped onto one of the world's largest multiresolution 3D photogrammetric reconstruction of the seafloor -- ScienceDaily

A recent expedition led by Dr. Blair Thornton, holding Associate Professorships at both the University of Southampton and the Institute of Industrial Science, the University of Tokyo, demonstrated how the use of autonomous robotics and artificial intelligence at sea can dramatically accelerate the exploration and study of hard to reach deep sea ecosystems, like intermittently active methane seeps. Thanks to rapid high throughput data analysis at sea, it was possible to identify biological hotspots at the Hydrate Ridge Region off the coast of Oregon, quickly enough to survey and sample them, within days following the Autonomous Underwater Vehicles (AUV) imaging survey. The team aboard research vessel *Falkor* used a form of Artificial Intelligence, unsupervised clustering, to analyze AUV-acquired seafloor images and identify target areas for more detailed photogrammetric AUV surveys and focused interactive hotspot sampling with ROV SuBastian.

This project demonstrated how modern data science can greatly increase the efficiency of conventional research at sea, and improve the productivity of interactive seafloor exploration with the all too familiar "stumbling in the dark" mode. "Developing totally new operational workflows is risky, however, it is very relevant for applications such as seafloor monitoring, ecosystem survey and planning the installation and decommissioning of seafloor infrastructure," said Thornton.

The idea behind this Adaptive Robotics mission was not to upturn the structure of how things are done at sea, but simply to remove bottlenecks in

the flow of information and data-processing using computational methods and Artificial Intelligence. The algorithms used are able to rapidly produce simple summaries of observations, and form subsequent deployment plans. This way, scientists can respond to dynamic changes in the environment and target areas that will lead to the biggest operational, scientific, or environmental management gains.

More than 1.3 million seafloor images were collected and algorithmically analyzed to find biological hotspots and precisely target them for interactive sampling and observations. The initial wide-area seafloor imagery was acquired with an underwater vehicle "Ae2000f" using high-altitude 3D visual mapping cameras at underwater sites between 680 and 780 meters depth. The international team deployed multiple AUVs, developed by the University of Tokyo, which were equipped with 3D visual mapping technology developed jointly by the University of Sydney, University of Southampton, and the University of Tokyo and the Kyushu Institute of Technology as part of an international collaboration.

The conversion of the initial wide area survey imagery into three dimensional seafloor maps and habitat type summaries onboard *Falkor*, allowed the researchers to plan the subsequent robotic deployments to perform higher resolution visual imaging, environmental and chemical surveying, and physical sampling in areas of greatest interest, particularly at the ephemeral hotspots of biological activity that intermittently form around transitory methane seeps. Nineteen AUV deployments and fifteen ROV dives were completed in total during the expedition, including several multi-vehicle operations.

Thanks to rapid processing of data, a photogrammetric map of one of the best studied gas hydrate deposits was completed. This is believed to be the largest 3D color reconstruction of the seafloor, by area, in the world, measuring more than 118,000 square meters or 11.8 hectares, and covering a region of approximately 500 x 350 meters. While the average resolution of the maps obtained is 6 mm, the areas of most interest were mapped with resolution an order of magnitude higher, which would not have been possible without the ability to intelligently target the sites of interest with high resolution imaging surveys and process the large volumes of acquired data within hours of their

acquisition at sea.

Normally, maps like this would take several months to process and only after the completion of an expedition, at which point the science team is no longer at the site, and the habitats may have already evolved or expired. Instead, the research team was able to compose the 3D maps on board of *Falkor* within days of the images being acquired. The composite map was used during the expedition to plan operations, including the recovery of seafloor instruments and was invaluable for revisiting specific sites, such as active bubble plumes, making the entire operation more efficient.

"It is quite amazing to see such large areas of the seafloor mapped visually, especially only days after the raw data was collected. It is not just the size of the map, but also the way we were able to use it to inform our decisions while still on site. This makes a real difference as the technology makes it possible to visualize wide areas at very high resolution, and also easily identify and target areas where we should collect data. This has not previously been possible," said Thornton.

You can learn more at https://schmidtocean.org/cruise/adaptive-robotics-at-barkley-canyon-and-hydrate-ridge/ and https://ocean.soton.ac.uk/

Story Source:

Materials provided by **Schmidt Ocean Institute**. *Note: Content may be edited for style and length.*

'Blink' and you won't miss amyloids: Engineering team just found new way to see proteins that cause Alzheimer's, other diseases -- ScienceDaily

Tiny protein structures called amyloids are key to understanding certain devastating age-related diseases. Aggregates, or sticky clumped-up amyloids, form plaques in the brain, and are the main culprits in the progression of Alzheimer's and Huntington's diseases.

Amyloids are so tiny that they can't be visualized using conventional microscopic techniques. A team of engineers at Washington University in St. Louis has developed a new technique that uses temporary fluorescence, causing the amyloids to flash, or "blink," and allowing researchers to better spot these problematic proteins.

"It has been pretty difficult, finding a way to image them in a non-invasive way -- not changing the way they come together -- and also figuring out a way to image them long-term to see how they clump and form larger structures," said Matthew Lew, assistant professor in the Preston M. Green Department of Electrical & Systems Engineering at the School of Engineering & Applied Science. "That was the focus of our research."

Currently, scientists seeking to visualize amyloids use large amounts of a fluorescent material to coat the proteins in a test tube. When using a fluorescence microscope, the amyloids glow. However, it isn't known how dyes that are permanently attached might alter the basic structure and behavior of the amyloid. It's also difficult to discern the nanoscale structures at play using this bulk experimental technique.

Lew, whose research focus includes super-resolution microscopy and single-molecule imaging, worked with his former Washington University colleague

Jan Bieschke, now an associate professor of brain science at University College in London, to develop the new technique that makes them blink. It's called transient amyloid binding (TAB) imaging.

TAB uses a standard dye called thioflavin T, but instead of coating the amyloids, it temporarily sticks to them one at a time. The effect isn't permanent, and the amyloids emits light until the dye detaches, yielding a distinctive blinking effect. The researchers were able to use a fluorescence microscope to observe and record the blinks. They then localized the position of each blinking thioflavin and reconstructed a super-resolved picture of the exact amyloid structure.

"The thioflavin T behaved like a group of fireflies, lighting up anytime they come into contact with the amyloid," Bieschke said.

"What we saw were flashes of light over time," Lew said. "On our computer screens, you'd see these individual spots blinking in sequence. We were then able to overlay all these dots together, giving us a complete look at the structure. If you didn't separate them out, you'd see a blur."

The team tested the TAB technique on a variety of amyloid structures and were able to reconstruct images for all of them, over an extended period of time and at various stages of aggregation. Their results were recently published in the journal *ChemBioChem*.

"There's an intimate connection between seeing the proteins' structure and learning how these proteins interact with neurons," Lew said. "Ultimately, we need the imaging to understand all of the different shapes and structures that these proteins are building over time, and how that relates to the death of cells later on."

Story Source:

Materials provided by **Washington University in St. Louis**. Original written by Erika Ebsworth-Goold. *Note: Content may be edited for style and length.*

Robotic herding of a flock of birds using drones -- ScienceDaily

Researchers made a new algorithm for enabling a single robotic unmanned aerial vehicle to herd a flock of birds away from a designated airspace. This novel approach allows a single autonomous quadrotor drone to herd an entire flock of birds away without breaking their formation.

Professor David Hyunchul Shim at KAIST in collaboration with Professor Soon-Jo Chung of Caltech and Professor Aditya Paranjape of Imperial College London investigated the problem of diverting a flock of birds away from a prescribed area, such as an airport, using a robotic UVA. A novel boundary control strategy called the m-waypoint algorithm was introduced for enabling a single pursuer UAV to safely herd the flock without fragmenting it.

The team developed the herding algorithm on the basis of macroscopic properties of the flocking model and the response of the flock. They tested their robotic autonomous drone by successfully shepherding an entire flock of birds out of a designated airspace near KAIST's campus in Daejeon, South Korea. This study is published in *IEEE Transactions on Robotics*.

"It is quite interesting, and even awe-inspiring, to monitor how birds react to threats and collectively behave against threatening objects through the flock. We made careful observations of flock dynamics and interactions between flocks and the pursuer. This allowed us to create a new herding algorithm for ideal flight paths for incoming drones to move the flock away from a protected airspace," said Professor Shim, who leads the Unmanned Systems Research Group at KAIST.

Bird strikes can threaten the safety of airplanes and their passengers. Korean civil aircraft suffered more than 1,000 bird strikes between 2011 and 2016. In the US, 142,000 bird strikes destroyed 62 civilian airplanes, injured 279 people, and killed 25 between 1990 and 2013. In the UK in 2016, there were

1,835 confirmed bird strikes, about eight for every 10,000 flights. Bird and other wildlife collisions with aircraft cause well over 1.2 billion USD in damages to the aviation industry worldwide annually. In the worst case, Canadian geese knocked out both engines of a US Airway jet in January 2009. The flight had to make an emergency landing on the Hudson River.

Airports and researchers have continued to reduce the risk of bird strikes through a variety of methods. They scare birds away using predators such as falcons or loud noises from small cannons or guns. Some airports try to prevent birds from coming by ridding the surrounding areas of crops that birds eat and hide in.

However, birds are smart. "I was amazed with the birds' capability to interact with flying objects. We thought that only birds of prey have a strong sense of maneuvering with the prey. But our observation of hundreds of migratory birds such as egrets and loons led us to reach the hypothesis that they all have similar levels of maneuvering with the flying objects. It will be very interesting to collaborate with ornithologists to study further with birds' behaviors with aerial objects," said Professor Shim. "Airports are trying to transform into smart airports. This algorithm will help improve safety for the aviation industry. In addition, this will also help control avian influenza that plagues farms nationwide every year," he stressed.

For this study, two drones were deployed. One drone performed various types of maneuvers around the flocks as a pursuer of herding drone, while a surveillance drone hovered at a high altitude with a camera pointing down for recording the trajectories of the pursuer drone and the birds.

During the experiments on egrets, the birds made frequent visits to a hunting area nearby and a large number of egrets were found to return to their nests at sunset. During the time, the team attempted to fly the herding drone in various directions with respect to the flock.

The drone approached the flock from the side. When the birds noticed the drone, they diverted from their original paths and flew at a 45? angle to their right. When the birds noticed the drone while it was still far away, they adjusted their paths horizontally and made smaller changes in the vertical direction. In the second round of the experiment on loons, the drone flew

almost parallel to the flight path of a flock of birds, starting from an initial position located just off the nominal flight path. The birds had a nominal flight speed that was considerably higher than that of the drone so the interaction took place over a relatively short period of time.

Professor Shim said, "I think we just completed the first step of the research. For the next step, more systems will be developed and integrated for bird detection, ranging, and automatic deployment of drones." "Professor Chung at Caltech is a KAIST graduate. And his first student was Professor Paranjape who now teaches at Imperial. It is pretty interesting that this research was made by a KAIST faculty member, an alumnus, and his student on three different continents," he said.

Environment News

Top stories featured on ScienceDaily's Plants & Animals, Earth & Climate, and Fossils & Ruins sections.

- **High precision microbial population dynamics under cycles of feast and famine** [周三, 05 9月 04:45]
  Scientists have produced the most precise picture to date of population dynamics in fluctuating feast-or-famine conditions. Biological physicists found that bacterial population density is a function of both the frequency and the amplitude of nutrient fluctuations.
- **California: Global warming, El Niño could cause wetter winters, drier conditions in other months** [周三, 05 9月 03:04]
  New research indicates that what future precipitation California gets will be pretty much limited to the winter months -- think deluge-type rainfall rather than snow -- and non-winter months will be even dryer than usual, with little or no rain at all.
- **Giving tortoises a 'head start'** [周三, 05 9月 03:04]
  Research indicates that head-starting -- raising a species in captivity and releasing it into a protected habitat after it has grown large enough to be less vulnerable to predators -- is a useful intervention for boosting the state's gopher tortoise population.
- **Parsing natural climate variability from human-caused climate change** [周三, 05 9月 03:03]
  A new study says pink noise may be the key to separating out natural climate variability from climate change that is influenced by human activity.
- **Superbug discovery renews hope for antibiotic treatment** [周三, 05 9月 02:06]
  Bacteria that were thought to be resistant to a powerful antibiotic may be susceptible to treatment after all, research has found.
- **Dementia symptoms peak in winter and spring, study finds** [周三, 05 9月 02:06]
  Adults both with and without Alzheimer's disease have better cognition skills in the late summer and early fall than in the winter and spring, according to a new study.
- **Fossil teeth show how Jurassic reptiles adapted to changing seas** [周三, 05 9月 02:06]
  Marine predators that lived in deep waters during the Jurassic Period thrived as sea levels rose, while

species that dwelled in the shallows died out, research suggests.

- **State-of-the-art imaging techniques reveal heightened detail and beauty of vertebrate life** [周三, 05 9月 02:06]
  A mingling of science and art, the next-generation photographs of vertebrate skeletons are at once fascinating, eerie, intricate and exquisite.

- **What could have extended human lifespan? Researchers identify 25 genetic changes** [周三, 05 9月 02:06]
  A new method has made it possible to identify 25 parallel mutations located in genes associated with wound healing, blood coagulation and cardiovascular disorders. The results could help to develop new drugs to treat aging-related diseases. The research confirms the theory that some genes that help us in the initial stages of life are harmful to us once the reproductive stage has ended.

- **The gens isiaca in Hispania: Egyptian gods in Roman Spain** [周二, 04 9月 23:47]
  Researchers have developed a geo-localized database which enables archaeological pieces from ancient religions to be located on the Iberian Peninsula. This platform, named "The gens isiaca in Hispania", provides a catalogue with more than 200 remains from the Roman age on Isis and other Egyptian gods.

- **Reducing nitrogen inputs prevents algal blooms in lakes** [周二, 04 9月 23:47]
  For decades, experts have debated whether reducing the amount of nitrogen flowing into lakes can improve water quality in the long-term, even though blue-green algae can bind nitrogen from the air. Scientists have now shown that the amount of atmospheric nitrogen bound by blue-green algae is far too small to be used as an argument against the ecologically necessary reduction of nitrogen inputs.

- **A breakthrough for Australia's fish** [周二, 04 9月 23:47]
  A research team has made a breakthrough that could help dwindling numbers of Australian freshwater fish species. Researchers say the innovation will allow small and young fish to get past barriers like culverts.

- **Severely traumatized refugees may not necessarily develop PTSD** [周二, 04 9月 23:47]
  Heavily traumatized people such as refugees fleeing war, torture and natural catastrophes may not necessarily develop posttraumatic stress disorder (PTSD), a new study reveals.

- **Individual metering of heating consumption could lead to savings of up to 20 percent** [周二, 04 9月 23:47]
  Researchers have conducted a detailed study of the changes in habits brought about by individual metering and charging of heating and domestic hot water in a community of residents.

- **New way to see dirty underside of glaciers** [周二, 04 9月 23:47]
  Accurate projections of sea level rise require sophisticated models for glacier flow, but current approaches do a poor job capturing the physical processes that control how fast glaciers slide over sediments, according to researchers. In a new study, they've proposed a theoretical approach that sheds

light on the dirty, dark undersides of glaciers and improve the modeling of ice flow.

- **Coral bleaching on Great Barrier Reef not limited to shallow depths** [周二, 04 9月 23:47]
  A new study demonstrates that the recent mass coral bleaching on the Great Barrier Reef was not restricted to shallow depths, but also impacted deep reefs. Although deep reefs are often considered a refuge from thermal anomalies, the new research highlights limitations to this role and argues that both shallow and deep reefs are under threat of mass bleaching events.

- **How much insects eat** [周二, 04 9月 23:47]
  A first-of-its-kind study used herbarium specimens to track insect herbivory across more than a century, and found that, across four species -- shagbark hickory (Carya ovata), swamp white oak (Quercus bicolor), showy tick trefoil (Desmodium canadense) and wild lowbush blueberry (Vaccinium angustifolium) -- specimens collected in the early 2000s were 23 percent more likely to be damaged by insect herbivores than those collected in the early 1900s.

- **Satellites more at risk from fast solar wind than a major space storm** [周二, 04 9月 22:32]
  Satellites are more likely to be at risk from high-speed solar wind than a major geomagnetic storm according to a new study.

- **Powerful tools to solve challenges in bio- and circular economy** [周二, 04 9月 22:32]
  Researchers have developed an efficient synthetic biology toolbox for industry and research organizations. This toolbox enables, in an unprecedented way, engineering of a diverse range of yeasts and fungi.

- **Body temperature regulation: How fever comes** [周二, 04 9月 22:32]
  Researchers performed a microdialysis study on mice to determine mechanisms underlying the inflammatory response in the brain associated with fever that might be used to develop new strategies for treatment.

- **Like a zipper -- how cells form new blood vessels** [周二, 04 9月 22:32]
  Blood vessel formation relies on the ability of vascular cells to move while remaining firmly connected to each other. This enables the vessels to grow and sprout without leaking any blood. Scientists now describe how this works. In this process, the cytoskeleton pushes the cell forward, while an adhesion protein subsequently closes the gap to the neighboring cell, like a zipper.

- **Blue-green algae promises to help boost food crop yields** [周二, 04 9月 22:32]
  Scientists have engineered tiny carbon-capturing engines from blue-green algae into plants, in a breakthrough that promises to help boost the yields of important food crops such as wheat, cowpeas and cassava.

- **Greenhouse emissions from Siberian rivers peak as**

permafrost thaws [周二, 04 9月 22:32]
Permafrost soils store large quantities of frozen carbon and play an important role in regulating Earth's climate. Researchers now show that river greenhouse gas emissions rise high in areas where Siberian permafrost is actively thawing.

- **New imagery solves mystery of why Mount St. Helens is out of line with other volcanoes** [周二, 04 9月 21:38]
  Some of the clearest, most comprehensive images of the top several miles of the Earth's crust have helped scientists solve the mystery of why Mount St. Helens is located outside the main line of the Cascade Arc of volcanoes.
- **Biophysics: Self-centered** [周二, 04 9月 20:51]
  Rod-shaped bacterial cells normally divide by constriction midway along their long axis. Physicists have developed a theoretical model to explain how Myxococcus xanthus localizes the plane of division to mid-cell.
- **Natural 'breakdown' of chemicals predicts lung damage in 9/11 firefighters** [周二, 04 9月 20:20]
  Abnormal levels of more than two dozen metabolites -- chemicals produced in the body as it breaks down fats, proteins and carbohydrates -- can reliably predict which Sept. 11 firefighters developed lung disease and which did not, a new analysis shows.
- **Can social media networks reduce political polarization on climate change?** [周二, 04 9月 03:29]
  Political bias often leads to polarization on topics like climate change. But a new study has shown that exposure to anonymous, bipartisan social networks can make a striking difference, leading both liberals and conservatives to improve their forecasting of climate-change trends.
- **Evolutionary origins of animal biodiversity** [周二, 04 9月 03:29]
  A new study has revealed the origins and evolution of animal body plans.
- **Tracking marine migrations across geopolitical boundaries aids conservation** [周一, 03 9月 23:34]
  A new study uses tracking data for 14 species of migratory marine predators, from leatherback turtles to blue whales and white sharks, to show how their movements relate to the geopolitical boundaries of the Pacific Ocean. The results provide critical information for designing international cooperative agreements needed to manage these species.
- **Scientists pioneer a new way to turn sunlight into fuel** [周一, 03 9月 23:33]
  A new study used semi-artificial photosynthesis to explore new ways to produce and store solar energy. They used natural sunlight to convert water into hydrogen and oxygen using a mixture of biological components and human-made technologies.
- **Mud from the deep sea reveals clues about ancient**

monsoon [周一, 03 9月 23:33]
The Sonoran Desert is one of the world's most biodiverse deserts, thanks to the annual monsoon, which provide a source of moisture in addition to seasonal winter rains. Researchers were able to access untapped clues about the monsoon's activity during the last ice age, about 20,000 years ago. Their findings help scientists predict how regional climates may respond to future conditions.

- **Chaos-inducing genetic approach stymies antibiotic-resistant superbugs** [周一, 03 9月 22:17]
A genetic disruption strategy effectively stymies the evolution of antibiotic-resistant bacteria such as E. coli, giving scientists a crucial leg up in the ongoing battle against deadly superbugs.

- **8,000 new antibiotic combinations are surprisingly effective** [周一, 03 9月 22:15]
Biologists have identified more than 8,00 new combinations of antibiotics that are surprisingly effective. 'We expect several of these combinations, or more, will work much better than existing antibiotics,' said one of the researchers, a professor of ecology and evolutionary biology.

- **A new way to remove ice buildup without power or chemicals** [周六, 01 9月 03:01]
Researchers have found a way to prevent icing of powerlines, airplanes, wind turbines, and other surfaces with a special coating and the power of sunlight -- no heating or harsh chemicals needed.

- **Cryptosporidiosis worsened in mice on probiotics** [周六, 01 9月 01:32]
In an unexpected research finding infections with the intestinal parasite, Cryptosporidium parvum, worsened in mice that had been given a probiotic.

- **Eating in 10-hour window can override disease-causing genetic defects, nurture health** [周六, 01 9月 01:01]
Scientists found that mice lacking the biological clocks thought to be necessary for a healthy metabolism could still be protected against obesity and metabolic diseases by having their daily access to food restricted to a 10-hour window.

- **Are vulnerable lions eating endangered zebras?** [周五, 31 8月 23:04]
Are Laikipia's recovering lions turning to endangered Grevy's zebras (Equus grevyi) for their next meal?

- **Allergists warn that chigger bites may cause allergic reaction to red meat** [周五, 31 8月 23:03]
Chiggers, redbugs, harvest mites -- whatever you call them, they are pesky little bugs whose bites cause really itchy rashes, usually around the ankles and waistline.

- **A computational analysis identifies a new clinical phenotype of severe malaria** [周五, 31 8月 23:03]

There are more clinical phenotypes of severe malaria than those defined by the World Health Organization (WHO), according to a new study. The results indicate that heart failure can be a pathogenic mechanism of disease, which has implications in the clinical management of these patients.

- **Synthetic microbiome? Genetic engineering allows different species of bacteria to communicate** [周五, 31 8月 21:09]
  What if the bacteria that live in your gut could monitor your health, report disease, and produce beneficial molecules? Researchers have gotten one step closer to creating such a 'synthetic microbiome' by engineering different species of bacteria so they can talk to each other. Given that there are over 1,000 different strains of intestinal interlopers in the human gut, such coordination is crucial for the development of systems that can sense and improve human digestive health.

- **Mechanism of Marburg virus sexual transmission identified in nonhuman primates** [周五, 31 8月 06:01]
  New research elucidates the mechanism of sexual transmission of filoviruses, which have been shown to persist in the testes and other immune privileged sites. Sexual transmission of filoviruses was first reported in 1968 after an outbreak of Marburg virus disease and recently caused flare-ups of Ebola virus disease in the 2013-2016 outbreak. The team found that Marburg virus persists in seminiferous tubules and that Sertoli cells are the reservoir for the virus.

- **Using physics to predict crowd behavior** [周五, 31 8月 06:01]
  Electrons whizzing around each other and humans crammed together at a political rally don't seem to have much in common, but researchers are connecting the dots. They've developed a highly accurate mathematical approach to predict the behavior of crowds of living creatures, using methods originally developed to study large collections of quantum mechanically interacting electrons.

- **Countries ranked by oil production emissions** [周五, 31 8月 06:01]
  Emissions associated with oil and gas production are a significant source of greenhouse gases. A new analysis ranks countries by emission levels and identifies the major sources of emissions, a first step toward policy to regulate oil and gas production practices.

- **Inhibiting nuclear factor kappa B improves heart function in a mouse model of Duchenne muscular dystrophy** [周五, 31 8月 06:01]
  Researchers have uncovered an unexpected mechanism that underlies cardiomyopathy (heart failure) in Duchenne muscular dystrophy (DMD). They report that nuclear factor kappa B down-regulates calcium genes, contributing to cardiomyopathy in DMD. Furthermore, data from a mouse model show cardiomyocyte ablation of NF-kappaB rescues cardiac function.

- **Scientists identify protein that may have existed when life began** [周五, 31 8月 06:01]
  How did life arise on Earth? Researchers have found among the first and perhaps only hard evidence that simple protein catalysts -- essential for cells, the building blocks of life, to function -- may have existed when life began.

- **Faster than we thought: Sulfurization of organic material** [周五, 31 8月 06:00]
  Processes that were thought to take tens of thousands of years can happen in hours, according to new research. And that may change our understanding of the carbon cycle, and maybe the history of Earth's climate.
- **Biomechanics of chewing depend more on animal size, not diet** [周五, 31 8月 02:34]
  Researchers report that the jaw joint bone, the center around which chewing activity revolves (literally), appears to have evolved based more on an animal's size than what it eats.
- **Injection wells can induce earthquakes miles away from the well** [周五, 31 8月 02:32]
  A study of earthquakes induced by injecting fluids deep underground has revealed surprising patterns, suggesting that current recommendations for hydraulic fracturing, wastewater disposal, and geothermal wells may need to be revised.
- **DNA accessibility, gene expression jointly profiled in thousands of cells** [周五, 31 8月 02:32]
  A new assay can concurrently trace, in thousands of different cells, the marks that shape what each cell's genome will do -- the epigenome -- and the copies of the instructions themselves -- the transcriptome. The epigenome and transcriptome are part of the molecular biology that converts the genetic blueprint of DNA into tools and materials for living cells.
- **Simple test detects disease-carrying mosquitoes, presence of biopesticide** [周五, 31 8月 02:32]
  A new tool uses a smartphone camera, a small 3D-printed box and a simple chemical test to show whether a dead mosquito belongs to the Aedes aegypti species, which carries Zika and other devastating viruses that afflict an estimated 100 million people worldwide each year.

High precision microbial population dynamics under cycles of feast and famine: Automated sampling and measuring provides around-the-clock data collection -- ScienceDaily

Scientists at the University of Illinois at Urbana-Champaign have produced the most precise picture to date of population dynamics in fluctuating feast-or-famine conditions. Professor Seppe Kuehn, a biological physicist, and his graduate student Jason Merritt found that bacterial population density is a function of both the frequency and the amplitude of nutrient fluctuations. They found that the more frequent the feast cycles and the longer a feast cycle, the more rapid the population recovery from a famine state. This result has important implications for understanding how microbial populations cope with the constant nutrient fluctuations they experience in nature.

The team's findings were made possible by extraordinarily precise measurements of population dynamics in bacterial communities. The measurement, based on automated imaging of hundreds of millions of single cells, allowed the team to capture population dynamics over periods of more than a week with a temporal resolution of one minute. Those numbers and the extended duration of the experiment couldn't have happened without Merritt's continuous-culture systems, coupled to automated-sampling fluorescence microscopes.

These findings are published in the August 28 issue of *Physical Review Letters*.

The experimental setup took about two years and many prototypes to develop. Merritt built six identical systems for the experiment, each one automated to continuously pump in fresh media and pump out bacterial cultures for sampling. The samples were continuously imaged to track

changes in population density and structure. Software developed by Merritt automatically segments images to count bacterial cells, producing massive data sets. The software takes advantage of machine learning to resolve otherwise difficult-to-solve problems in image recognition and processing.

Kuehn comments, "Scientists studying populations of bacteria typically take samples manually and do their counting offline, in person. What Jason's systems do is automatically remove a sample, pass it in front of a microscope to be imaged, and then put it back. And they do that once a minute, 24 hours a day, with no input, for up to a month. His software counts the cells in the images, extracting information in real time."

He continues, "So that's a big step forward -- this has never been achieved before. Short-timescale quantitative studies have been done using microfluidic devices, but these are limited to about three days' runtime. We can run for 30 days, producing long-timescale highly quantitative measurements. We can easily run replicate experiments, reproducing the same results. Because of this, we were able to use the system to test hypotheses about the underlying mechanisms governing the dynamics we observed."

Merritt comments, "The idea for the system grew out of previous work Seppe had done. The device I built is basically a metal block with glass vials within it. The most important part of our system and the part that was the most difficult to get to work reliably is the coupling to a fluorescence microscope."

The system continuously draws samples out of the liquid culture into flexible tubing and then into a thin glass capillary in the path of the microscope. The bacteria pass through the capillary many at a time, but are spaced apart from one another. The biggest challenge overall was on the software side, doing proper image segmentation to convert the images to data.

The main finding, that populations apparently recovery faster from more frequent or larger pulses of nutrients, puzzled the team at first. However, the precision of the measurement allowed them to uncover the mechanism.

Merritt continues, "What we found out is that the fast recovery rates for the planktonic population are driven by dispersal from aggregated cells

(biofilms) during feast conditions. So basically when there's a lot of food, these cell aggregates start shedding cells rapidly, and the cells that shed off start growing rapidly. But during famine conditions when there's not very much food, these cells start coming back together and forming the aggregates again. This is the mechanism driving the frequency and amplitude dependence."

Kuehn adds, "Variations in a natural population may be the result of any one or a combination of many different variables -- the amount of nutrients, temperature, competition and predation, etc. -- so it's difficult to measure cause and effect. In the lab, we tightly control all of the parameters of our experiment. And now we can make a really robust and reproducible quantitative measurement. Going forward, we would like to modify these systems to study topics in evolutionary history. We also plan to do studies in which we use feedback control of microbial communities, to see whether we can push the communities back into a particular state. These are studies that wouldn't be possible without an automated system like the one we used in this study."

California: Global warming, El Niño could cause wetter winters, drier conditions in other months: Warming ocean temperatures will intensify winter rainfall in California -- ScienceDaily

So here's the good news: Despite fears to the contrary, California isn't facing a year-round drought in our warming new world.

However, UC Riverside Earth Sciences Professor Robert Allen's research indicates that what precipitation the state does get will be pretty much limited to the winter months -- think deluge-type rainfall rather than snow -- and non-winter months will be even dryer than usual, with little or no rain at all.

"It is good news," Allen said. "But only relative to the alternative of no rain at all."

Allen's latest findings build on his 2017 research that concluded global warming will bring increased winter precipitation to California through the end of this century.

The findings are outlined in a paper by Allen and his co-author Ray Anderson, research soil scientist at the USDA-ARS US Salinity Lab, titled "21st century California drought risk linked to model fidelity of the El Niño teleconnection." It was published September 3 in *Climate and Atmospheric Science*.

The paper focuses on how "greenhouse-gas-induced climate change" will affect drought conditions in the state. The findings are based on 40 climate models that were compared to actual precipitation, soil moisture, and streamflow in the state between 1950 and 2000.

Historically, about 90 percent of California's rain and snow have come during the winter months of December, January, and February, Allen said, with sporadic rain scattered over the rest of the year. But now, warming surface temperatures in the tropical Pacific Ocean are expected to amplify the rainy season by sending stormy El Niño conditions over the state in the winter.

Bottom line, Allen said, the flooding and mudslides that accompanied the heavy winter rains of 2017 shouldn't be considered an aberration, but potentially California's new weather norm.

The trick will be finding a way to capture excess water for dry periods, he said. "It's all about smoothing the seasonable differences. If we can take advantage of the enhanced winter rainfall, we can hopefully get through the drying trends the rest of the year."

Trapping that winter precipitation will be a challenge, however, especially since it's likely to come more in the form of rain than snow due to the warming climate. Historically, snow in the mountains feeds reservoirs and provides water to agriculture when it is needed in the summer, but rain will just run off unless it is captured.

Allen's findings also bode ill for California's fire season. The state's new norm could mimic -- or surpass -- the fire season of 2017, the worst in California's history, as wet winters encourage lush spring growth that will quickly parch during the hot and dry season, becoming wildfire fuel.

In fact, Allen said, these "new norm" projections aren't for a distant future.

"I think it's here now, so we need to start acting as quickly as possible," he said. "Adaptation is incredibly important in response to climate change, and in this case it means enhancing our water storage capabilities, our reservoirs and dam structures, because things are going to become drier in the nonwinter months."

And for ordinary citizens? This might be a great time to start investing in rain barrels.

"In Southern California, it could mean having native plants in your yard

because a grass yard has to be irrigated, and that's probably not the wisest use of water," he said. "It's all about living sustainably."

Giving tortoises a 'head start': Raising gopher tortoises in captivity may boost wild populations -- ScienceDaily

Research from the University of Georgia indicates that head-starting -- raising a species in captivity and releasing it into a protected habitat after it has grown large enough to be less vulnerable to predators -- is a useful intervention for boosting the state's gopher tortoise population, which has been declining in numbers for decades due to predation, poaching and loss of suitable habitat.

Seventy percent of head-started tortoises raised from donor eggs were still alive a year after release at Yuchi Wildlife Management Area in Burke County, according to research by Tracey Tuberville and Dan Quinn. They published their findings in the *Journal of Wildlife Management*.

The gopher tortoise, Georgia's state reptile, is a keystone species whose burrows provide shelter for more than 250 other species, said Tuberville, associate research scientist at the Savannah River Ecology Laboratory and adjunct faculty at the Warnell School of Forestry and Natural Resources.

Despite predation risks at the release site, survival rates were higher than survival reported for their wild counterparts, according to Quinn, a graduate student at SREL and Warnell during the research.

Quinn conducted two soft-releases of yearlings at YWMA during consecutive years. The team said the second release was the largest tortoise release in the state to date.

"We initially released the tortoises into pens to acclimate them into the natural environment," he said. "This gives them time to construct a burrow and in theory it reduces predation risk."

Forty-two of 145 yearlings were radio tracked and monitored for a year following the soft releases, providing information to inform future head-starting efforts.

Tracking data revealed that the juveniles demonstrated a strong rate of site fidelity, remaining together in a protected area, which allows them to reproduce. This means the soft-release technique is not necessary, according to Tuberville.

Instead, the researchers will implement multiple releases in various locations to help reduce predation risk. Predators included fire ants, raccoons and dogs, with fire ants accounting for the majority of fatalities.

Head-starting efforts at YWMA will continue with tortoises that are 2 to 3 years old, an age when they are less susceptible to predators, Tuberville said. Additional research will evaluate whether the positive effect on post-release survival warrants the additional time in captivity.

Story Source:

Materials provided by **University of Georgia**. *Note: Content may be edited for style and length.*

Parsing natural climate variability from human-caused climate change -- ScienceDaily

A new study says pink noise may be the key to separating out natural climate variability from climate change that is influenced by human activity.

Not familiar with pink noise? It's a random noise in which every octave contains the same amount of energy. Pink noise is found in systems ranging from earthquakes and electronics to biology and stellar luminosity. Compared to the more familiar white noise, pink noise has more low-frequency components.

Writing in the journal *Physical Review Letters*, Yale researcher John Wettlaufer, graduate student Sahil Agarwal, and first author and Yale graduate Woosok Moon of Stockholm University found that pink noise energy signatures on decadal time scales appear in historical climate proxy data both before and after the Industrial Revolution.

"A central question in contemporary climate science concerns the relative roles of natural climate variability and anthropogenic forcing -- climate change related to human involvement -- which interact in a highly nonlinear manner on multiple timescales, many of which transcend a typical human lifetime," said Wettlaufer, the A.M. Bateman Professor of Geophysics, Mathematics and Physics at Yale.

"We find that the observed pink noise behavior is intrinsic to Earth's climate dynamics, which suggests a range of possible implications, perhaps the most important of which are 'resonances' in which processes couple and amplify warming," Wettlaufer said.

Story Source:

Materials provided by **Yale University**. *Note: Content may be edited for style and length.*

Superbug discovery renews hope for antibiotic treatment -- ScienceDaily

Bacteria that were thought to be resistant to a powerful antibiotic may be susceptible to treatment after all, research has found.

The food-poisoning bug Listeria was shown to respond to an antibiotic even though the bacteria carry genes that should make it highly resistant.

Scientists say the antibiotic -- called fosfomycin -- should be reconsidered as a treatment for life-threatening Listeria infections.

Early lab tests had indicated that fosfomycin fails to kill Listeria because the bacteria carry a gene that enables it to break down the drug.

Further studies, however, found that the drug was effective at killing Listeria in infected cells in the lab and in mice.

Genes that are only activated when the bacteria infect the body cancel out the effects of the drug-destroying gene, researchers at the University of Edinburgh found.

The findings suggest fosfomycin could prove to be a useful treatment for life-threatening Listeria cases despite these bacteria testing resistant based on laboratory tests, the researchers say.

Listeria infection -- also known as listeriosis -- is the most lethal food-borne disease known and is often fatal. It is caused by eating contaminated foods such as soft cheeses, smoked salmon, pates, meats and salads.

The infection is particularly deadly for those with weak immune systems, such as older people and newborns. It can also cause miscarriage.

These bacteria reproduce within the cells of the body and frequently affect the brain, which only certain medicines are able to treat. This limits the

treatment options for serious infections, and so fosfomycin may prove highly beneficial.

The study, published in the journal *PLOS Genetics*, was funded by Wellcome.

Professor Jose Vazquez-Boland, who led the research at the University of Edinburgh's Division of Infection Medicine, said: "Our study focused on Listeria, but this important discovery may be relevant for other species of bacteria too. It is encouraging that we may be able to repurpose existing drugs in the race against antibiotic resistance."

Story Source:

Materials provided by **University of Edinburgh**. *Note: Content may be edited for style and length.*

Dementia symptoms peak in winter and spring, study finds -- ScienceDaily

Adults both with and without Alzheimer's disease have better cognition skills in the late summer and early fall than in the winter and spring, according to a new study published this week in *PLOS Medicine* by Andrew Lim of Sunnybrook Health Sciences Centre and the University of Toronto, Canada, and colleagues.

There have been few previous studies concerning the association between season and cognition in older adults. In the new work, researchers analyzed data on 3,353 people enrolled in three different cohort studies in the U.S., Canada, and France. Participants had undergone neuropsychological testing and, for some participants, levels of proteins and genes associated with Alzheimer's disease were available.

The authors found that average cognitive functioning was higher in the summer and fall than the winter and spring, equivalent in cognitive effect to 4.8 years difference in age-related decline. In addition, the odds of meeting the diagnostic criteria for mild cognitive impairment or dementia were higher in the winter and spring (odds ratio 1.31, 95% CI: 1.10-1.57) than summer or fall. The association between season and cognitive function remained significant even when the data was controlled for potential confounders, including depression, sleep, physical activity, and thyroid status. Finally, an association with seasonality was also seen in levels of Alzheimer's-related proteins and genes in cerebrospinal fluid and the brain. However, the study was limited by the fact that each participant was only assessed once per annual cycle, and only included data on individuals from temperate northern-hemisphere regions, not from southern-hemisphere or equatorial regions.

"There may be value in increasing dementia-related clinical resources in the winter and early spring when symptoms are likely to be most pronounced," the authors say. "By shedding light on the mechanisms underlying the seasonal improvement in cognition in the summer and early fall, these

findings also open the door to new avenues of treatment for Alzheimer's disease."

Story Source:

Materials provided by **PLOS**. *Note: Content may be edited for style and length.*

Fossil teeth show how Jurassic reptiles adapted to changing seas -- ScienceDaily

Marine predators that lived in deep waters during the Jurassic Period thrived as sea levels rose, while species that dwelled in the shallows died out, research suggests.

A study of fossilised teeth has shed light on how reptiles adapted to major environmental changes more than 150 million years ago, and how sea life might respond today.

It also reveals for the first time that the broad structure of food chains beneath the sea has remained largely unchanged since the Jurassic era.

For more than 18 million years, diverse reptile species lived together in tropical waters that stretched from present-day northern France to Yorkshire in the north of England.

Until now, however, little was known about the structure of the food chain in this region -- called the Jurassic Sub-Boreal Seaway -- or how it changed as sea levels rose.

By analysing the shape and size of teeth spanning this 18-million-year period when water levels fluctuated, palaeontologists at the University of Edinburgh found that species belonged to one of five groups based on their teeth, diet and which part of the ocean they inhabited.

The pattern is very similar to the food chain structure of modern oceans, where many different species are able to co-exist in the same area because they do not compete for the same resources, the team says.

As global sea levels rose, reptiles that lived in shallow waters and caught fish using thin, piercing teeth declined drastically, researchers found.

At the same time, larger species that inhabited deeper, open waters began to thrive. These reptiles had broader teeth for crunching and cutting prey.

Deep-water species may have flourished as a result of major changes in ocean temperature and chemical make-up that also took place during the period, the team says. This could have increased levels of nutrients and prey in deep waters, benefitting species that lived there.

The study offers insights into how species at the top of marine food chains today might respond to rapid environmental changes -- including climate change, pollution and rising temperatures.

The study, which also involved the University of Bristol, is published in the journal *Nature Ecology & Evolution*. It was supported by the Leverhulme Trust, Marie Sk?odowska-Curie Actions, Systematics Research Fund, Palaeontographical Society and Palaeontological Association.

Davide Foffa, of the University of Edinburgh's School of GeoSciences, who led the study, said: "Studying the evolution of these animals was a real -- and rare -- treat, and has offered a simple yet powerful explanation for why some species declined as others prospered. This work reminds us of the relevance of palaeontology by revealing the parallels between past and present-day ocean ecosystems."

Dr Steve Brusatte, also of the University's School of GeoSciences, said: "Teeth are humble fossils, but they reveal a grand story of how sea reptiles evolved over millions of years as their environments changed. Changes in these Jurassic reptiles parallel changes in dolphins and other marine species that are occurring today as sea-levels rise, which speaks to how important fossils are for understanding our modern world."

Story Source:

Materials provided by **University of Edinburgh**. *Note: Content may be edited for style and length.*

State-of-the-art imaging techniques reveal heightened detail and beauty of vertebrate life -- ScienceDaily

A mingling of science and art, the next-generation photographs of vertebrate skeletons are at once fascinating, eerie, intricate and exquisite.

"People are inherently interested in how these skeletons look," said W. Leo Smith, associate professor of ecology and evolutionary biology and associate curator at the University of Kansas Biodiversity Institute & Natural History Museum. "In any given scholarly paper, you'd be lucky to have a couple of hundred people read it top to bottom -- but a lot more people will look at the images. The more we can improve that, the more people you can get interested in your research."

Since the 1800s, biologists and paleontologists have taken pictures of specimens to perform comparative anatomical studies. Now, techniques pioneered by Smith and a team of researchers headquartered at KU are giving scientists around the world fresh methods to capture images of vertebrates -- a breakthrough enabling better, more useful digital pictures of Earth's biodiversity.

The team describes the two novel imaging procedures in a new paper appearing in the peer-reviewed journal *Copeia*.

One new process involves "cleared and stained" specimens, which have been stripped of their muscles in a time-honored technique using cow enzymes. The team discovered how to position such specimens within a glycerine-gelatin mixture for otherwise impossible images.

"The problem we had was we couldn't pose these animals because we've digested away all of the muscles," Smith said. "They're flaccid and useless, like a pile of clothes that fold in every direction. We wanted the ability to

pose them."

The researchers hunted for the best ratio of glycerine and gelatin that allowed specimens to be posed in a nondestructive medium that could be simply washed off after photography. Much of the "nitty gritty" work was performed by doctoral student Matthew Girard and intern Chesney A. Buck, an aspiring taxidermist interning with Smith's group from Van Go Inc., an arts-based employment program for at-risk teens and young adults.

"She was interested in artistic taxidermy, mixing animal parts like have been done with the jackalope," Smith said. "She knew about clearing and staining and wanted to know how to do it. After her internship, she volunteered for a year more. There was a lot of trial and error. We tried lots of different things."

Other co-authors on the new paper are Gregory S. Ornay, Rene P. Martin and Girard of KU's Biodiversity Institute, along with Matthew P. Davis and Sarah Z. Gibson of St. Cloud State University.

Eventually, the team found a 40 percent glycerine mixture that held specimens well and was sufficiently translucent for photography, allowing them new looks at specimens that could "float" within the matrix.

"You can see through this medium and give the specimen structure," Smith said. "Now you can get a photo of a fish specimen head on and look at it from all these different angles. There's something different about being able to see anatomical structure in new ways that really does help analysis. Before, we struggled with how to pose these things. For instance, fish are famous for having two sets of jaws, an oral set like ours and then another set of teeth where our voice box is -- you couldn't get a photo of these teeth head-on before now."

Smith said the new technique could be used on a host of vertebrate species beyond the fishes he studies.

"It'd be great to pose a snake coiled, but before now they just wouldn't hold in that pose. Or if you were trying to get an image of some structure obscured by the wing of a bird and couldn't get it out of the way, we've often had to cut

the wing off, but now you could deflect the wing to show that structure."

A second method developed by the group employs fluorescent microscopy to examine specimens and create captivating images of alizarin-stained recent and fossil vertebrates. The work hinges on the fact that alizarin, a stain long used in the clearing and staining process to identify bones in a specimen, fluoresces when exposed to the right wavelengths of light -- a phenomenon Smith discovered himself. (Another team independently discovered the phenomenon in a paper about zebrafish.)

"Alizarin red is used to dye a specimen's bones, and it fluoresces like a Grateful Dead poster," Smith said. "We use lights that have high energy and look for reflections of re-emitted fluorescent wavelength, and the microscope has filters that block all the other light. The skin and everything else disappears because it doesn't fluoresce -- it's a fast way to clear out all the extra stuff and is incredibly useful when you're trying to see where bones are connected. It was pure luck to find this."

The KU researcher reported the fluorescence microscopy finding to colleagues last year at the annual meeting of the American Society of Ichthyologists and Herpetologists, and today other investigators in the field already are using the matrix in their own digital imaging work thanks to the presentation.

"Now lots of people are doing it," Smith said. "It's been really rewarding. You feel like you contributed something to make this kind of research more interesting and allow us to study anatomy better."

While Smith doesn't consider the how-to descriptions of new imaging techniques to be of equal weight as the scientific papers he regularly produces, he stressed the importance of providing compelling images to conveying information to fellow investigators and the public alike.

"At end of the day, the picture is worth a thousand words," he said. "Images allow you to fundamentally share how things work and improve your ability to tell someone else about your novel discoveries."

https://www.sciencedaily.com/releases/2018/09/180904140605.htm

What could have extended human lifespan? Researchers identify 25 genetic changes -- ScienceDaily

Senescence, or biological aging, refers to the general deterioration of an organism's physiological functions, leading to increased susceptibility to diseases and ultimately death. It is a complex process that involves many genes. Lifespans vary greatly across different animal species. Thus, for example, flies live for four weeks, horses for thirty years, whereas some hedgehogs may live for up to two centuries. Why is the range of lifespans in nature so broad? This is one of the basic and most intriguing questions faced by biologists.

Potentially, human beings can live for up to 120 years, whereas the species of some closer primates live for half that period. In order to explain the reasons behind these differences, researchers from the Institute of Evolutionary Biology (IBE), a mixed centre belonging to the Pompeu Fabra University (UPF) and the Spanish National Research Council (CSIC), in collaboration with scientists from the Centre for Genomic Regulation (CRG), the University of Bristol and the University of Liverpool, have identified some of the genes that may have been crucial in extending the life of our species, as well as that of primates with a longer lifespan. The study has been published in the *Molecular Biology & Evolution* journal and is featured on the front cover.

In this work, the researchers studied the genomes of seventeen primate species, including humans. From the standpoint of aging, primates are interesting because while they are very similar, there are major differences across the different species in terms of longevity. Hence, of all the species studied, only three ? humans and two macaques ? lived longer than the common ancestor, which proves that "they have undergone a relatively rapid process of lifespan evolution," explains Arcadi Navarro, ICREA research professor at the IBE and the study leader.

The genes of these three species were compared to those of the remaining fourteen species in order to detect the mutations present in those with a longer life. "This would constitute very suggestive evidence that these genes have helped to extend their lives," says Navarro, who is also Professor of the UPF and CRG collaborator. Following the comparison, twenty-five mutations were identified in genes associated with wound-healing, coagulation and a large number of cardiovascular conditions.

"The results are meaningful, because a flexible and adaptable control of coagulation mechanisms are required in species that live longer," explains Gerard Muntané, the study's leading author and a postdoctoral researcher at the IBE and at the Institut d'Investigació Sanitària Pere Virgili (IISPV). Moreover, adds Muntané, "they confirm the pleiotropy theory of aging," which proposes that "certain mutations may have different effects depending on life-stage: they help us in the early stages but damage us in later stages, once the reproductive stage has ended."

The authors suggest that the results could help to develop new therapeutic targets for treating aging-related diseases and to demonstrate the potential of an evolutionary approach to medicine.

Story Source:

Materials provided by **Center for Genomic Regulation**. *Note: Content may be edited for style and length.*

The gens isiaca in Hispania: Egyptian gods in Roman Spain -- ScienceDaily

This database has been created by the Historiography and History of Religions research group from UC3M, under the leadership of Ancient History professor Jaime Alvar, in collaboration with the university's Library Service. The project enables the classification and geo-location of a set of archaeological pieces related to the goddess Isis, recovered from the three provinces of Roman Hispania (Baetica, Lusitania and Tarraconensis) between the 1st cent. BCE and the 3rd cent. CE.

Part of its innovation is its magnitude, as it triples the number of pieces registered on this topic from previous catalogues: "The main advantages are that it provides direct access to ground-breaking information and the immediate update of datasheets." There is no need to wait for a new paper edition. What is more, the geo-location allows any abnormal distribution of materials to be observed. Practically the entire centre of the Iberian Peninsula has no findings, since they are mainly concentrated on the Catalan coast, in Occidental Andalusia and the capital of Lusitania, Mérida," explains Jaime Alvar.

One of the aims of this research is to analyse the conditions of the reception of cultural change and the re-appropriation process of ancient rituals: "How do different sociocultural strata of a community which has been invaded and cross-cultured as a consequence of the Roman conquest act?" You can see how active oligarchies are in the process of generation of social change, or how dominated social groups are less interested in it," Alvar points out.

The development of the database has been carried out in two stages: an initial stage of design, development, inclusion of content and processing of images, and a second stage of geo-location through a personalised Google map where the location of each of the items is determined. "We have created a kind of dialogue between the database and the geo-location, in such a way that if you access the description of the piece you can click on the link and go to the map

to see where it was located and where it is being stored" notes Inmaculada Muro, in charge of research support for the UC3M Humanities Library.

With regards to the Library's collaboration on the project, Teresa Malo, manager of the UC3M Library Service, stresses that the libraries "are no longer simply a warehouse storing knowledge but have rather become a factor in the spreading of knowledge."

The database updates and expands on what is covered in Jaime Alvar's book Los cultos egipcios en Hispania (2012) (Egyptian cults in Hispania), with the advantages of the digital environment: "It allows you to update, modify, correct, delete or add information to the existing datasheets or to other new ones, so that the user can know how recent the data they are viewing is," Jaime Alvar concludes.

In its initial stages, this tool was designed to facilitate the work of specialists in the subject. However, the general public's potential interest in it was later identified: "Some colleagues from the Faculty have already mentioned to me that they had found districts they have an emotional connection with on the map, which lead them to look at which materials had been found in that place. That is to say, it is also entertaining for a non-expert," Alvar comments.

This research is being developed within the framework of the "Oriental Religions in Spain" (ORINS) project, funded by the Ministry of Economy and Competition, for the publication of online catalogues of the cults of the gens isiaca, of Mithras, and of Mater Magna in Hispania. What is more, they have collaborated with the ARYS Association: Antigüedad, Religiones y Sociedades (Antiquity, Religions and Societies), the Institut de Sciences et Techniques de l'Antiquité de l'Université de Franche-Comté (ISTA) and the Dykinson publishing house as co-editor.

Video: https://www.youtube.com/watch?v=UTV3yoM5_g0

Story Source:

Materials provided by **Universidad Carlos III de Madrid**. *Note: Content may be edited for style and length.*

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Reducing nitrogen inputs prevents algal blooms in lakes: Less is more: reduced nitrogen has greater potential than originally thought -- ScienceDaily

For decades, experts have debated whether reducing the amount of nitrogen flowing into lakes can improve water quality in the long-term, even though blue-green algae can bind nitrogen from the air. However, no lakes with decreased nitrogen inputs have been monitored for long enough to clarify this -- until now: scientists from the Leibniz-Institute of Freshwater Ecology and Inland Fisheries (IGB) have analysed long-term data to prove that decreasing nitrogen in Berlin's Lake Müggelsee is the key to reducing algal blooms in summer. They showed that the amount of atmospheric nitrogen bound by blue-green algae is far too small to be used as an argument against the ecologically necessary reduction of nitrogen inputs.

In the 1970s, scientists discovered that nutrient inputs -- mainly phosphorus and nitrogen -- from agriculture and wastewater discharge were the main cause of excessive plant and algal growth in lakes and rivers. Since then, water management experts have concentrated on reducing phosphorus inputs. "Although this strategy often works, it is by no means always successful. In shallow lakes, the sediment releases large quantities of phosphorus in summer. In these cases, reducing nitrogen input may help to control algal blooms because algae need both phosphorus and nitrogen to grow. Until now, however, there has been no convincing evidence that decreasing nitrogen inputs, which is more complex and costly than decreasing phosphorus, works in the long term," stated IGB freshwater ecologist Dr. Tom Shatwell, explaining the starting point of the study.

Long-term data provide deep insight

To conduct their investigation, the scientists statistically analysed 38 years of

data (1979-2016). Since the 1970s, Lake Müggelsee (in Berlin, Germany) and its tributaries have been sampled on a weekly basis as part of a long-term programme to investigate phosphorus and nitrogen concentrations as well as the species composition in algal communities. Müggelsee is one of the few lakes in the world that have experienced a significant decrease in phosphorus and nitrogen pollution and that have been monitored for a sufficiently long time to draw conclusions on the effects of reducing nitrogen inputs.

Every summer, there was an excess of phosphorus in the water of Lake Müggelsee. The scientists concluded it was the decrease in nitrogen that caused algae blooms to decrease -- and water clarity to increase. Contrary to common views, blue-green algae species did not replace the nitrogen missing from the tributaries with nitrogen from the atmosphere in the long term. In fact, blue-green algae did not increase in abundance and there was very little binding of atmospheric nitrogen. "It takes much more energy to fix atmospheric nitrogen than it does to use nitrogen compounds present in the water. Blue-green algae obviously only use this method when absolutely necessary and when there is sufficient solar energy," explained Dr. Jan Köhler, co-author and leader of the "Photosynthesis and Growth of Phytoplankton and Macrophytes" research group at IGB.

Story Source:

Materials provided by **Forschungsverbund Berlin**. *Note: Content may be edited for style and length.*

A breakthrough for Australia's fish -- ScienceDaily

A research team from the Threatened Species Recovery Hub has made a breakthrough that could help dwindling numbers of Australian freshwater fish species.

Dr Jabin Watson from the University of Queensland says the innovation will allow small and young fish to get past barriers like culverts.

"Simple things like dams, culverts and weirs can be enough to prevent fish from migrating, accessing habitat and even escaping predators," said Dr Watson.

"These kinds of barriers are a major contributor to the declines and local extinctions of many Australian fish species."

Native fish in the Murray Darling Basin are estimated to be at only ten per cent of pre European numbers.

"When streams pass through a culvert -- the pipes under most roads -- the flow is concentrated," Dr Watson said.

"This fast flow can be impossible for many fish to navigate as they simply can't swim that fast for that long.

"Small and young fish are particularly impacted."

The team used a biohydrodynamics laboratory at UQ to test the swimming ability and behaviour of native fish species.

"Many different types of devices have been trialled in Australia to help fish move past barriers like culverts," Dr Watson said.

"Baffles are frequently used, with the aim of giving fish areas to rest along

the way, but our laboratory testing has shown that the turbulence created can really knock fish about and make them disorientated.

"We've discovered a completely new approach that has proved very successful in laboratory trials, enabling small and young fish to navigate fast flows.

"We have taken advantage of a property of fluid mechanics called the boundary layer to create a channel of slower flowing water along one side of the culvert," he said.

"The boundary layer is a thin layer of slower water generated by a fluid moving across a solid surface, such as the bed and walls of a culvert.

"By adding a beam along the culvert wall, we have added another surface close to the culvert corner.

"The boundary layers from these three surfaces merge to create a reduced velocity channel that is large enough for small fish to swim through.

Dr Watson said no native fish species have evolved to cope with things like culverts.

"Strategies that work to improve fish passage provide hope for our freshwater species," Dr Watson concludes.

Story Source:

Materials provided by **University of Queensland**. *Note: Content may be edited for style and length.*

Severely traumatized refugees may not necessarily develop PTSD -- ScienceDaily

Heavily traumatized people such as refugees fleeing war, torture and natural catastrophes may not necessarily develop posttraumatic stress disorder (PTSD), a new study reveals.

Researchers worked with a group of refugees -- half suffering from PTSD, the others not -- and asked them to suppress neutral memories. Results showed that participants who struggled to control these thoughts were more likely to show symptoms of PTSD.

The research raises the question of whether the ability to control memories protects against developing PTSD or if the condition causes an impairment in an individual's ability to control their memories?

Experts at the University of Birmingham, Ruhr-Universität Bochum, the University of Konstanz and Berlin's Max Planck Institute for Human Development worked with 24 refugees from a range of European, African and Asian countries to complete the study, which is published in *Scientific Reports*.

They found that the more severe the PTSD symptoms, the more difficult refugees found suppressing neutral memories. Their study also indicated that efforts to forget the memories caused problems in remembering non-traumatic experiences.

The research indicates that PTSD patient's problems in suppressing traumatic memories relates to dysfunctional gamma frequency activity in the brain -- a discovery that could help to shape more effective treatments.

Dr Simon Hanslmayr, Reader in Cognitive Neuroscience at the University of Birmingham, commented: "Difficulties experienced by people with severe PTSD symptoms when attempting to suppress bad memories is linked to the

ability to regulate gamma frequency brain activity.

"This novel biomarker could help identify risks posed to PTSD patients by memory suppression techniques and assist in adapting and developing psychotherapeutic methods. Our study certainly raises concerns about unwary use of memory suppression in treating PTSD sufferers."

The researchers note that more research is needed into the effects of traumatic stress in refugees. This would help to develop effective medical strategies to deal with the immediate health and socioeconomic challenges posed by high numbers of refugees.

Dr Gerd Waldhauser, from the Institute of Cognitive Neuroscience at Ruhr University Bochum, commented: "Refugees and asylum seekers are often excluded from medical treatment or do not seek help. They are often unable or unwilling to take part in deamanding cognitive neuroscience studies, making data such as ours precious in understanding a rarely-studied population with abundant mental health problems."

PTSD is a disorder characterised by the recurrent and uncontrollable intrusion of traumatic memories. Patients tend to try to suppress these intrusions which can aggravate the condition's symptoms and cause further emotional distress.

Researchers worked with a group of 24 refugees, who took part in a series of tests whilst being observed with magnetoencephalography (MEG) brain imaging technology which registered the different frequencies of brain activity they exhibited.

Story Source:

Materials provided by **University of Birmingham**. *Note: Content may be edited for style and length.*

Individual metering of heating consumption could lead to savings of up to 20 percent -- ScienceDaily

Metering and charging on an individual basis of heating and hot water consumption is at varying levels of development in European countries. The 2012/27/EU Directive on energy efficiency published in 2012 stipulated the compulsory nature of implementing this kind of system across all member states. Despite the 2016 deadline laid down by the directive for the states to transpose the directive into their internal legislation, today "this has not been done here; right now, there is a draft Royal Decree by which the directive will be transposed, but it has yet to be passed," explained Jon Terés, a member of the ENEDI research group at the UPV/EHU's Faculty of Engineering -- Bilbao and one of the authors of this study.

Despite the fact that current legislation does not yet make this compulsory, "an attempt has been made by installation and maintenance companies and even property administrators to encourage individualisation in communities with centralised heating systems, in other words, those in which a heating and domestic hot water system, and cooling, where appropriate, is supplied to more than one end user. That is why there are more and more communities of residents that decide to go ahead with the installation, although the vast majority of buildings with centralised installations built before 1998 still do not have these systems," he said.

The ENEDI research group has conducted a detailed study of the savings to be made through the individualisation of the metering and charging of the heating and water consumed in a block of about 140 flats in Bilbao. As the researcher explained, the aim sought by this study was "to find out how much energy was being saved through this measure in temperate climates. Most of the studies of this type have been carried out in the north of Europe where climate conditions in winter are much harsher. We aimed to see the extent to which the results of these studies could be extrapolated to our climate, where

the winters are much milder."

In the study conducted they compared the community's heating oil consumption during the two years prior to the intervention with the consumption over the two years that followed. "The results revealed energy savings in the building studied of up to 20% during the period studied; these percentages of savings are very similar to those seen in publications focussing on the conditions in the north of Europe. What is more, in this particular case study, the payback period on investment would be about 10 years, perfectly manageable for systems of this type," specified Terés.

Greater control of and flexibility in consumption

The main difference resulting from consumption on an individual basis is that it allows greater flexibility in the use of the heating system and the possibility of adjusting it to the needs of each home; and when the users pay on the basis of consumption, they become more aware of their use of heating and domestic hot water. As a general rule, this awareness underpins the reduction in consumption in the homes in the block.

What happens in communities where consumption is not on an individual basis, is that "the residents are often unable to turn the system on and off, and the heating functions on the basis of what the community has agreed, following criteria with respect to the calendar and time of day, irrespective of whether the homes are occupied or not in that period, or the temperature that each user wants to have in his/her home; the scenario emerges of having the windows open in winter and the heating turned on," specified the researcher. Furthermore, the heating cost is shared out on the basis of criteria that have nothing to do with the consumption made, such as the number of square metres of each flat.

In view of the results, Terés believes that this case study constitutes "an interesting starting point for this type of study in temperate climates. Right now, we are working on the study of individual consumption, because there are some residents who save much more than others, and we would have to conduct the same study on a bigger number of blocks of flats and perhaps taking longer periods of time into consideration to be able to extrapolate and draw general conclusions from the results."

Story Source:

Materials provided by **University of the Basque Country**. *Note: Content may be edited for style and length.*

New way to see dirty underside of glaciers: How freezing sediment influences the sliding speed of glaciers -- ScienceDaily

Accurate projections of sea level rise require sophisticated models for glacier flow, but current approaches do a poor job capturing the physical processes that control how fast glaciers slide over sediments, according to University of Oregon researchers.

In a new study, the UO team, led by postdoctoral researcher Colin Meyer, offered a theoretical approach that helps to shed light on what they call the dirty, dark undersides of glaciers and improve the modeling of ice flow.

Detailed in a July article in the journal *Nature Communications*, the approach captures how the amount of sediment frozen to a glacier's base varies with the underlying water pressure, melting rate and particle size. It helps account for resulting changes in frictional resistance to glacier sliding.

To illustrate their theory, the UO researchers noted that regardless of the size or weight of a glacier, sliding accommodates ice flow that is driven by gravity and adjusts surface slopes so that friction at the bed never exceeds more than about 1 bar of stress.

"This is a longstanding problem," Meyer said. "If we want to forecast what glaciers are going to do in the future, we have to talk about the place that we can't see: the interface between the ice and the bed."

Formulations dating from the early 1950s attributed this upper stress limit to the plastic-like nature of ice deformation. In their paper, however, the UO researchers noted that 50 percent of all glaciers, including those that move the most ice off land in Greenland and Antarctica into the sea, are sliding.

The earlier explanation for 1 bar of frictional stress was based on

observations by Paul Mercanton, a Swiss geophysicist, in 1950 and the analysis of John Nye, now professor emeritus at the University of Bristol in the United Kingdom, in 1952.

"Nye's work carried the caveat that the formula only works for non-sliding areas," said Alan Rempel, a professor in the UO's Department of Earth Sciences and the paper's senior author. "It's not the complete story. It only applies if the glacier is stuck."

Using their new theory, which combined mathematical analysis with satellite data and geological evidence from regions previously covered by ice sheets, the UO team matched the 1 bar limit. The result provided confidence that freezing sediments is the physical process that controls the friction of the ice-sediment interface. The importance of freezing sediment, Meyer said, will be influential in developing more accurate ice flow models.

The theory's incorporation of freezing sediment provides a more complete view of glacial movement, Rempel said. "It focuses on the sliding and should help scientists accurately find the velocity of an advancing or receding glacier."

"If we want to understand how fast sea levels are going to rise, we need to know how fast the ice sheets are going to disintegrate," Meyer said. "We need to understand the role of friction at the base of a big glacier. Does water lubricate the interface or is the glacier frozen to the sediments? This friction sets how fast glaciers can flow."

The rate of sliding, Rempel said, is key to understanding impacts on sea level.

"The hypothesis that we've pushed forward is that the physics of how glacier ice interacts with its bed is exactly the same physics as how ice interacts with dirt in the world around us," Rempel said. "What we've looked at are conditions under which ice will just slide over dirt versus when ice sinks into and takes the dirt along with it."

Incorporating frozen sediment into sliding laws, Rempel said, will lead to more accurate projections of sea level rise based on glacier-related

conditions.

Story Source:

Materials provided by **University of Oregon**. *Note: Content may be edited for style and length.*

Coral bleaching on Great Barrier Reef not limited to shallow depths -- ScienceDaily

A new study demonstrates that the recent mass coral bleaching on the Great Barrier Reef was not restricted to shallow depths, but also affected deep reefs. Although deep reefs are often considered a refuge from thermal anomalies, the new research highlights limitations to this role and argues that both shallow and deep reefs are under threat of mass bleaching events. Published today in the journal *Nature Communications*, the study focuses on the mass bleaching event in 2016 that caused the death of 30% of shallow-water corals on the Great Barrier Reef. It details how the impacts of this bleaching lessened over depth, but were still substantial on deep reefs.

"During the bleaching event, cold-water upwelling initially provided cooler conditions on the deep reef," says study co-author Dr. Pim Bongaerts, curator of invertebrate zoology and *Hope for Reefs* co-leader at the California Academy of Sciences. "However, when this upwelling stopped towards the end of summer, temperatures rose to record-high levels even at depth."

Lead author Dr. Pedro Frade from the Center of Marine Sciences (CCMAR) says the research team was astounded to find bleached coral colonies down to depths of 131 feet beneath the ocean's surface. "It was a shock to see that the impacts extended to these dimly lit reefs, as we were hoping their depth may have provided protection from this devastating event."

The Great Barrier Reef is known to harbor extensive areas of deep coral reefs that are notoriously difficult to study. Using remotely operated vehicles (ROVs), the team deployed sensors to 328 feet beneath the ocean's surface to characterize how temperature conditions at depth differ from those in shallow habitats.

A team of divers then conducted surveys during the height of bleaching across a number of sites on the northern Great Barrier Reef. They noted that overall, major bleaching and mortality affected almost a quarter of corals at

the deep sampling points, while confirming previous reports of impacts on close to half the shallower corals.

"Unfortunately, this research further stresses the vulnerability of the Great Barrier Reef," says Dr. Ove Hoegh-Guldberg from The University of Queensland, where the study was conducted. "We already established that the refuge role of deep reefs is generally restricted by the limited overlap in species with the shallow reef. However, this adds an extra limitation by demonstrating that the deep reefs themselves are also impacted by higher water temperatures."

The researchers will continue to study how the process of recovery varies between shallow and deep reefs.

Story Source:

Materials provided by **California Academy of Sciences**. *Note: Content may be edited for style and length.*

How much insects eat: Study uses Herbarium samples to understand link between climate change and insect herbivory -- ScienceDaily

When she set out to understand whether climate changes over the past century might be effecting how much insects were eating various plants, Emily Meineke decided to go straight to the source -- the plants themselves.

A post-doctoral researcher currently working in the lab of Professor of Organismic and Evolutionary Biology and Harvard University Herbaria Director Charles Davis, Meineke is the lead author of a first-of-its-kind study that used herbarium specimens to track insect herbivory across more than a century. The study is described in a September 4 paper published in the *Journal of Ecology*.

In addition to Meineke, the paper is co-authored by Aimée Classen and Nathan Sanders, who are affiliated with the University of Vermont and the Gund Institute for Environment, and Jonathan Davies, an associate professor at University of British Columbia.

Across four species -- shagbark hickory (*Carya ovata*), swamp white oak (*Quercus bicolor*), showy tick trefoil (*Desmodium canadense*) and wild lowbush blueberry (*Vaccinium angustifolium*) -- the study found that specimens collected in the early 2000s were 23 percent more likely to be damaged by insect herbivores than those collected in the early 1900s.

The data also showed that insect damage was greater following warmer winters and at low latitudes, Meineke said, suggesting that the higher temperatures driven by climate change could be a factor driving insect damage.

"The overwhelming pattern is that across these four different plant species,

with different life histories, insect damage is increasing over time," she said. "In New England, it appears that warming in winter is an important factor driving insect herbivory damage overall.

"Knowing that insect damage on these plants is increasing is useful because we might be able to come up with management strategies before it reaches economic levels," she continued. "I think this study is the tip of the iceberg. Now that we know these plants have more damage than they did 100 years ago, we can try to understand what that actually means for plants."

To understand whether herbivory was increasing, Meineke and colleagues developed a detailed system for measuring not just whether specimens showed insect damage, but how much.

"Instead of just outlining the amount of a specimen that we think was removed by insects, or just saying this specimen has damage or doesn't, we actually wanted to be able to quantify it," Meineke said. "To do that, we laid a grid over each specimen, then randomly selected 5 grid cells and marked whether the leaves inside the grid cell were eaten or not, so our approach was a fine-scale measurement."

One of the challenges the study faced, Meineke said, came in understanding exactly what damage in the specimens was caused by insects.

"Vertebrates chomp off either half a leaf or the whole leaf," she said. "That's rare on herbarium specimens. When insects eat the plants before they're collected, the plant leaves a sort of scar around the damage that's analogous to a human scar.

"But the trouble is that the plants are also eaten within herbaria by a suite of herbivores, and particularly for the older specimens that weren't as well protected, we had to figure out a way to tell when specimens had been eaten before they were collected, and this type of scar tissue is found on just about every plant species we looked at."

Armed with those data, Meineke and colleagues developed a model to examine how herbivory changed over more than a century, but ran into another hurdle in the fact that herbarium specimens aren't randomly sampled.

"What you would hope for is to have a random sample across space collected every few years," she said. "But instead we have these sporadic samples. One way we deal with that is to include as many variables in the model as we can, so we included day of year when a specimen was collected, latitude, longitude, and human population density. The idea is that because you have accounted for all of these other variables...that gives you more explanatory power when it comes to the what's happening over time."

In addition to highlighting the connection between a warming climate and insect herbivory, the study also revealed that urbanization can have the opposite effect.

"We know that urbanization has important effects on insects," Meineke said. "There was a study that looked at 16 cities in Europe and found that the prevalence of insect damage is lower inside cities that outside. We found a similar pattern in New England, and even though it did not explain a lot about how much plants were eaten... urbanization is having a localized effect on insect damage. Overall, though, in New England climate change is having a bigger effect.

"What this means for the future, in my opinion, is that as urbanization accelerates locally, it could counteract the effects of climate change in the sense that you might actually see less insect damage in and around urban centers," she continued. "But in more rural forests, you'll see insect damage increasing over time."

While the study serves to illustrate one of the less understood aspects of climate change, Meineke said it also highlights the value of herbarium collections in answering such questions.

"It's hard to quantify the value of these collections," she said. "Because in fact they're invaluable. You can't go back and collect them again, and now these specimens have a renewed value because they can help us understand issues like climate change, invasive species, land use change, and pollution.

"There are debates taking place right now about whether to get rid of physical museum specimens now that many of them are digitized," she added. "But we can't because we don't know what sort of DNA technology or RNA

technology might be available in the future to take advantage of these specimens. Even though they're imperfect and non-randomly sampled, they're the only records we have."

This research was supported with funding from a Discovery Grant from The Natural Sciences and Engineering Research Council of Canada and a National Science Foundation Postdoctoral Research Fellowship in Biology.

Satellites more at risk from fast solar wind than a major space storm -- ScienceDaily

Satellites are more likely to be at risk from high-speed solar wind than a major geomagnetic storm according to a new UK-US study published this week in the Journal *Space Weather*.

Researchers investigating the space weather risks to orbiting satellites calculated electron radiation levels within the Van Allen radiation belts. This ring-doughnut-shaped zone wraps around the Earth, trapping charged particles. Geostationary orbit lies inside the Van Allen radiation belts

The study, which analysed years of satellite data, found that electron radiation levels at geostationary orbit could remain exceptionally high for 5 days or more, even after the solar wind speed had died down. As a result, electronic components on satellites could charge up to dangerously high levels and become damaged.

Professor Richard Horne, lead author of the study, said:

"Until now we thought that the biggest risk to orbiting satellites was geomagnetic storms. Our study constructed a realistic worst-case event by looking at space weather events caused by high-speed solar wind flowing away from the Sun and striking the Earth. We were surprised to discover just how high electron radiation levels can go."

This new research is particularly interesting to the satellite industry. Professor Horne continues:

"Fast solar wind is more dangerous to satellites because the geomagnetic field extends beyond geostationary orbit and electron radiation levels are increased all the way round the orbit -- in a major geomagnetic storm the field is distorted and radiation levels peak closer to the Earth.

"Electronic components on satellites are usually protected from electrostatic charges by encasing them in metal shielding. You would have to use about 2.5 mm of aluminium to reduce charging to safe levels -- much more than is used at present. There are well over 450 satellites in geostationary orbit and so in a realistic worst case we would expect many satellites to report malfunctions and a strong likelihood of service outage and total satellite loss."

Dr Nigel Meredith, a co-author on the study, said:

"A few years ago, we calculated electron radiation levels for a 1 in 150 year space weather event using statistical methods. This study uses a totally different approach but gets a very similar result and confirms that the risk of damage is real."

The solar wind is a stream of particles and magnetic field flowing away from the Sun. It flows around the Earth's magnetic field and excites so-called 'chorus' plasma waves near geostationary orbit. Chorus waves accelerate electrons and form the Van Allen radiation belts. The chorus waves also travel along the geomagnetic field to the Polar Regions where they are detected on the ground at Halley Research Station, Antarctica.

Story Source:

Materials provided by **British Antarctic Survey**. *Note: Content may be edited for style and length.*

Powerful tools to solve challenges in bio- and circular economy -- ScienceDaily

VTT Technical Research Centre of Finland has developed an efficient synthetic biology toolbox for industry and research organisations. This toolbox enables, in an unprecedented way, engineering of a diverse range of yeasts and fungi. The toolbox comprises DNA parts which can be easily combined to create new biological systems.

The SES (Synthetic Expression System) toolbox enables expression of genes in yeasts and fungi considerably more efficiently and with better control than has been possible with previous methods. The toolbox is based on DNA components with well-defined functions and the components can be combined as if they were Lego bricks. In this way, molecular machines can be built, for example, for improved control of yeast cell performance in industrial bioprocesses for production of polymer precursors, fuels and medical compounds.

Because the components of the SES toolbox operate the same way in different species, they can be used to engineer species that have attractive properties, but which have due to lack of engineering tools not been studied or used in biotechnology applications in the past.

The SES toolbox is expected to enable development of numerous novel microbial production processes for valorization of various waste materials to higher value compounds. In doing so, the SES toolbox provides important solutions for bio- and circular economy challenges.

Story Source:

Materials provided by **VTT Technical Research Centre of Finland**. *Note: Content may be edited for style and length.*

https://www.sciencedaily.com/releases/2018/09/180904103240.htm

Body temperature regulation: How fever comes -- ScienceDaily

The appearance of fever is associated with the release in the hypothalamus of a lipid compound called prostaglandin E2 (PGE2), which has an important role in the regulation of body temperature. However, how PGE2 is supplied to or maintain in the brain, and the role of membrane transporters (in particular of the prostaglandin transporter OATP2A1, encoded by the gene SLCO2A1) in this process still needs to be elucidated.

To shed light on this question, Takeo Nakanishi at Kanazawa University, Japan, and colleagues performed a microdialysis study on mice, published in the *Journal of Neuroscience*. The researchers used mice with normal Slco2a1, with total Slco2a1 deficiency or with monocyte-/macrophage-specific Slco2a1 deficiency. They first injected the mice with physiological saline, observing the same body temperature for mice with and without SLCO2A1, indicating that the presence of OATP2A1 does not affect the basal body temperature. They then administered to the mice a pyrogen, lipopolysaccharide, that normally causes a fever. Indeed, mice with Slco2a1 developed a fever after 2h, whereas the pyrogenic effect of lipopolysaccharide was not observed in mice with total SLCO2A1 deficiency. They further demonstrate the body temperature of mice with monocyte-/macrophage-specific Slco2a1 deficiency was partially attenuated. Intriguingly, an inhibitor of OATP2A1 injected to the brain of rats with normal Slco2a1 inhibited the febrile response -- in this case only an initial rise in body temperature was observed.

The study reveals that the onset of fever is associated with increased PGE2 concentration in the hypothalamus interstitial fluid, but not in the cerebrospinal fluid, thus OATP2A1 seems to work by maintaining high levels of PGE2 in the hypothalamus, either by stimulating its secretion from glial cells in the hypothalamus and from brain capillary endothelial cells or by facilitating its transport through the blood-brain barrier. OATP2A1 seems to be involved in the secretion of PGE2 from macrophages, but OATP2A1 in

cells other than macrophages may also contribute to the febrile response.

This newly gained insight of the mechanisms underlying the inflammatory response in the brain associated with fever might be used to develop new strategies for treatment, pointing to OATP2A1 as a useful therapeutic target.

Story Source:

Materials provided by **Kanazawa University**. *Note: Content may be edited for style and length.*

Like a zipper -- how cells form new blood vessels -- ScienceDaily

Blood vessel formation relies on the ability of vascular cells to move while remaining firmly connected to each other. This enables the vessels to grow and sprout without leaking any blood. In *Nature Communications*, scientists from the Biozentrum at the University of Basel describe how this works. In this process, the cytoskeleton pushes the cell forward, while an adhesion protein subsequently closes the gap to the neighboring cell, like a zipper.

The blood vessels form a widely ramified supply system that passes through our body from head to toe. They serve as pathways for blood cells and transport oxygen as well as nutrients into each individual organ. In the embryo, blood vessels develop simultaneously in many different places, then connect with each other and thus form a complex network. The starting point of vascular growth are the so-called endothelial cells. These can migrate in groups out from a vessel and form new tubes, the capillaries.

Prof. Markus Affolter's team at the Biozentrum of the University of Basel uses the zebrafish as a model organism to investigate the development of blood vessels. In their current study, the scientists have shown that endothelial cells can migrate within vessel sprouts while remaining firmly attached to each other. If the cells were unable to remain attached, bleeding into the surrounding tissue would occur during vascularization.

Vascularization: constant rearrangement of endothelial cells

The transparency of the zebrafish embryo allows researchers to observe blood vessel formation live in the living organism. High-resolution time-lapse imaging of vascularization shows that the endothelial cells move over each other to form a capillary, thereby continuously rearranging their position in the newly forming vessel. Dr. Heinz-Georg Belting, head of the study, took a closer look at this process.

Migration and connection of vascular cells

During the rearrangement of the endothelial cells in the vessel, it is important that the cells elongate and migrate while constantly maintaining cell-cell junctions. The adhesion protein VE-cadherin and the cell skeleton play a crucial role in this process. "These two players must work closely together during these active cell movements," says Belting. "The cytoskeleton takes the first step; it ensures the elongation of the cell. VE-cadherin then anchors the cell protrusions to the neighboring cell. An additional protein finally stabilizes the newly formed endothelial cell junction. This repetitive process enables the cell to slowly creep forward." This mechanism works like a zipper, as soon as the cell has moved a little, the gap to the adjacent endothelial cell is closed.

Plasticity ensures growth and flexibility

The fact that the endothelial cells are very motile during blood vessel formation and yet always stay firmly connected ensures the plasticity of the vessel while maintaining its stability. "The ability of endothelial cells to recognize each other, to migrate and to form cell junctions prevents damage during growth. Furthermore, the blood vessels are flexible to respond to different conditions, such as fluctuations in blood pressure," says Belting "This plasticity also plays a role in wound healing, inflammation and immune response."

Story Source:

Materials provided by **University of Basel**. *Note: Content may be edited for style and length.*

Blue-green algae promises to help boost food crop yields -- ScienceDaily

Scientists at The Australian National University (ANU) have engineered tiny carbon-capturing engines from blue-green algae into plants, in a breakthrough that promises to help boost the yields of important food crops such as wheat, cowpeas and cassava.

Lead researcher Dr Ben Long from ANU said the discovery was a major leap forward in improving the way crops convert carbon dioxide, water and sunlight into energy -- a process called photosynthesis, which is one of the main limitations to crop yield.

"For the first time, we have inserted tiny compartments from cyanobacteria -- commonly known as blue-green algae -- into crop plants that form part of a system that could lead to a 60 per cent increase in plant growth and yield," said Dr Ben Long from the ANU Research School of Biology whose work has been funded by the international Realizing Increased Photosynthetic Efficiency (RIPE) consortium.

These compartments, called carboxysomes, are responsible for making cyanobacteria so efficient at transforming carbon dioxide into energy-rich sugars.

"Until now, inserting a carboxysome into a plant had been in the realm of science fiction and it has taken us more than five years to get to this point," Dr Long said.

"We are trying to insert a turbo-charged carbon-capturing engine into plants, by mimicking a solution that cyanobacteria -- the ancestors of modern plant chloroplasts, the green compartments where plants make their own food -- found millions of years ago."

Rubisco, the enzyme responsible for fixing carbon dioxide from the

atmosphere, is slow and finds it difficult to differentiate between carbon dioxide and oxygen, leading to wasteful energy loss.

"Unlike crop plants, cyanobacteria use what's called a 'CO_2 concentrating mechanism' to deliver large amounts of the gas into their carboxysomes, where their Rubisco is encapsulated," Dr Long said.

"This mechanism increases the speed in which CO_2 can be turned into sugar and minimises reactions with oxygen."

The Rubisco enzyme inside cyanobacteria can capture carbon dioxide and generate sugars about three times faster than the Rubisco found in plants.

Computer models have shown that upgrading plant photosynthesis to use this mechanism will lead to a dramatic increase in plant growth and yield.

"We still have a lot of work to do, but achieving this in tobacco plants was an absolute essential step that has shown us we can expect to see crops with functional CO_2 concentrating mechanisms in the future, producing higher yield," Dr Long said.

Co-researcher Professor Dean Price from the ANU Research School of Biology said the discovery offered a promising long-term strategy to enhance global crop yields and environmental resilience.

"We need every creative effort to improve crop yields if we want to be able to feed the growing global population and these options take time, so we need to do it now," said Professor Price, who is a Chief Investigator with the RIPE consortium and the Australian Research Council (ARC) Centre of Excellence for Translational Photosynthesis.

RIPE Director Stephen Long, Ikenberry Endowed University Chair of Crop Sciences and Plant Biology at the University of Illinois, welcomed the discovery.

"When we supported this research, starting five years ago, we knew this was very high risk, but went ahead given the very great rewards it could lead to," he said.

"We never expected to see carboxysomes in the crop chloroplast by this stage, maybe just pieces.

"So by assembling carboxysomes indistinguishable from those of cyanobacteria is a spectacular achievement, and puts us well on the road to be able to achieve the full system."

Greenhouse emissions from Siberian rivers peak as permafrost thaws -- ScienceDaily

As permafrost degrades, previously frozen carbon can end up in streams and rivers where it will be processed and emitted as greenhouse gases from the water surface directly into the atmosphere. Quantifying these river greenhouse gas emissions is particularly important in Western Siberia -- an area that stores vast amounts of permafrost carbon and is a home to the Arctic's largest watershed, Ob' River.

Now researchers from Umeå University (and collaborators from SLU, Russia, France, and United Kingdom) have shown that river greenhouse gas emissions peak in the areas where Western Siberian permafrost has been actively degrading and decrease in areas where climate is colder, and permafrost has not started to thaw yet. The research team has also found out that greenhouse gas emissions from rivers exceed the amount of carbon that rivers transport to the Arctic Ocean.

"This was an unexpected finding as it means that Western Siberian rivers actively process and release large part of the carbon they receive from degrading permafrost and that the magnitude of these emissions might increase as climate continues to warm" says Svetlana Serikova, doctoral student in the Department of Ecology and Environmental sciences, Umeå University, and one of the researchers in the team.

Quantifying river greenhouse gas emissions from permafrost-affected areas in general and in Western Siberia in particular is important as it improves our understanding the role such areas play in the global carbon cycle as well as increases our abilities of predicting the impacts of a changing climate on the Arctic.

"The large-scale changes that take place in the Arctic due to warming exert a strong influence on the climate system and have far-reaching consequences for the rest of the world. That is why it is important we focus on capturing

how climate warming affects the Arctic now before these dramatic changes happen" says Svetlana Serikova.

Story Source:

Materials provided by **Umea University**. *Note: Content may be edited for style and length.*

New imagery solves mystery of why Mount St. Helens is out of line with other volcanoes -- ScienceDaily

Some of the clearest, most comprehensive images of the top several miles of the Earth's crust have helped scientists solve the mystery of why Mount St. Helens is located outside the main line of the Cascade Arc of volcanoes.

A giant subsurface rock formation some 20-30 miles in diameter, known as the Spirit Lake batholith, appears to have diverted magma and partially melted rock outside of the arc and to the west, forming the region's most active volcano.

Results of the study, which was supported by the National Science Foundation and carried out in collaboration with the U.S. Geological Survey, are being published this week in *Nature Geoscience*.

Previous imaging studies have primarily utilized seismic methods. During natural earthquakes and artificially induced tremors -- by setting off explosions -- scientists can image some of the properties of subsurface rocks by tracking the sound waves. This method provides clues to the structure, density and temperature of the rocks.

More recently, researchers are using "magnetotelluric," or MT data, which measures the Earth's subsurface electrical conductivity. Variations in the geomagnetic and geoelectric fields can reveal much about the subsurface structure and temperature, as well as the presence of fluids such as magma.

"Either method by itself can lead to a level of uncertainty, but when you layer them together as we have done in this project you get a much clearer picture of what lies below," said Adam Schultz, an Oregon State University geophysicist who is principal investigator on the NSF grant to OSU and co-author on the *Nature Geoscience* paper.

"The longer you run the measurements, the crisper the images and the deeper you can 'see' the subsurface. We were focusing on the upper 12-15 kilometers of the crust, but with a longer experiment we could see 200 to 300 kilometers below the surface."

Understanding the formation of Mount St. Helens begins with plate tectonics. Similar to the present day, where the Juan de Fuca plate is being subducted beneath North America, in the past crustal blocks with marine sediments were "slammed into the continent, where they accreted," Schultz said.

"This material is more permeable than surrounding rock and allows the magma to move through it," he noted. "The big batholith acts kind of like a plug in the crust and diverted magma that normally would have erupted in line with the other major Cascade volcanoes, resulting in St. Helens forming to the west of the Cascadia Arc, and Mt. Adams slightly to the east."

Mount St. Helens experienced a major eruption in May of 1980 and since has gone through periods of dome-building (2004-08) and dormancy. A study in 2006 by researchers from the University of Canterbury in New Zealand provided some images of the volcano's subsurface. During the next year, Schultz and the author of the 2006 study will use magnetotelluric technology to gather new and hopefully crisper images to see how much has changed since that study.

Schultz said that the images from the latest study are clear enough that by continuously monitoring the geoelectric and geomagnetic fields, they may be able to detect changes in the movement of magma beneath Mount St. Helens, and perhaps other volcanoes.

"This may give us a new tool to monitor the magma cycle so we don't have to wait for the dome-building phase to tell us conditions are changing," Schultz said.

Story Source:

Materials provided by **Oregon State University**. *Note: Content may be edited for style and length.*

Biophysics: Self-centered -- ScienceDaily

Essential biological processes, such as cell division, must be tightly regulated. For example, correct localization of the plane of cell division is vital for correct segregation of the duplicated genomes, and hence for the survival of both daughter cells. Bacterial cells generally divide symmetrically by forming a contractile ring, which is progressively constricted to form two daughter cells of equal size. In a new study, LMU doctoral student Silke Bergeler and her supervisor Professor Erwin Frey have developed a model that explains how the plane of division is specified in the rod-shaped bacterium *Myxococcus xanthus*. The model, which is based on experimental work done by Professor Lotte Søgaard-Andersen and her group at the Max Planck Institute for Terrestrial Microbiology in Marburg, is described in the online journal *PLoS Computational Biology*.

Prior to cell division, the bacterial genome is replicated. The region occupied by the bacterial chromosome (or 'nucleoid') is functionally equivalent to the nucleus in the cells of higher organisms. When the cell divides, the nucleoid must be centered, so that the duplicated nucleoids are equally divided between the two daughter cells. Three proteins have been identified which are required for the proper localization of the plane of cleavage at mid-cell in *M. xanthus*. Experiments by the research group in Marburg have shown that two of these, named PomX and PomY, assemble to form a large cluster, which will ultimately mark the position of mid-cell. The third, PomZ, is an ATPase -- an enzyme that binds the nucleotide ATP and can convert it into ADP. Dimer molecules made of two ATP-bound PomZ proteins can attach to the chromosomal DNA and diffuse along it, and can also bind to the PomXY cluster and diffuse at a lower rate. The action of this system ensures that the cluster is localized to the midpoint of the nucleoid, which coincides with mid-cell, where the contractile ring will form.

"We have developed a mathematical model and used it to study the detailed dynamics of the process that leads to the positioning of the cluster in the center of the nucleoid," says Bergeler. The analysis revealed that the PomZ

proteins are the crucial components in this operation. They first bind to the chromosomal DNA and subsequently recruit the cluster, thus tethering it to the nucleoid. Simultaneous binding of PomZ to the cluster and the chromosomal DNA, however, eventually activates the ATPase activity of PomZ, which causes it to detach from both the cluster and the DNA. It then diffuses in the cytosol and finally binds randomly to the nucleoid again. In addition to this delay, one other factor plays an important role in shuttling the cluster to midnucleoid: The chromosome exhibits a certain degree of elasticity, such that a specific position on the chromosome can explore the region around its equilibrium position as a result of thermal fluctuations. "Thanks to this elasticity, PomZ proteins that are bound to both the chromosome and the PomXY cluster can exert a net force on the cluster." Moreover, simulations show that the velocity of the cluster depends on the difference between the fluxes of PomZ into the cluster from either side. "The crucial point is that, if the cluster is asymmetrically placed, more PomZ proteins will be fed into it from the direction of the longer segment of the nucleoid than from the opposite side," Bergeler explains. This imbalance in the flux of PomZ serves to push the cluster toward, rather than away from, mid-cell. When the cluster's location coincides with the center of the chromosome, it remains in place because the number of PomZ molecules impinging on it from each side is essentially the same.

According to its authors, the model is also of interest in the context of other intracellular positioning systems, such as the Min system used to center the contractile ring in *E. coli*, plasmid segregation, or the mechanisms that are responsible for the localization of flagella. "By studying the similarities and differences between the various systems, one can identify the general mechanisms on which they are based," says Frey. This view is supported by the finding that the proposed mechanism can in principle lead to two distinct dynamic behaviors. If the dynamics of PomZ's movement along the nucleoid is slow relative to the diffusion of the cluster, the latter does not stably maintain its position at midnucleoid. Instead, it oscillates back and forth about the center of the nucleoid.

Story Source:

Materials provided by **Ludwig-Maximilians-Universität München**. *Note:*

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Natural 'breakdown' of chemicals predicts lung damage in 9/11 firefighters -- ScienceDaily

Abnormal levels of more than two dozen metabolites -- chemicals produced in the body as it breaks down fats, proteins and carbohydrates -- can reliably predict which Sept. 11 firefighters developed lung disease and which did not, a new analysis shows.

Researchers say the results, published by NYU School of Medicine researchers in the journal *BMJ Open Respiratory Research* online Sept. 4, could lead to metabolic tests for early detection of lung damage in all disaster victims exposed to fine particles from fire, smoke, and toxic chemicals, not just 9/11 firefighters.

The study, researchers say, offers the first evidence that metabolite blood tests conducted within months of the disaster could still help in the detection of obstructive airway disease, or OAD. Such analysis could aid in diagnosing OAD in the roughly 9,000 firefighters exposed to toxic chemicals at the World Trade Center (WTC) on Sept. 11, 2001, or during the cleanup that followed.

Senior study investigator Anna Nolan, MD, says the team hopes to develop a precise chemical profile of firefighters most at risk of developing OAD -- including asthma, chronic bronchitis, and/or emphysema -- by analyzing fluid samples from 9/11 firefighters not included in the current study.

Nolan, an associate professor in the Department of Medicine at NYU Langone Health, says her team's findings raise the possibility that correcting metabolic imbalances -- through dietary changes or food supplements -- could ward off or even reverse loss of lung function. Already, the team has plans to test a low-calorie Mediterranean diet, known for its ability to rebalance the body's metabolites, for its potential effects on the firefighters'

lung health.

"Healthy lung function is essential for everyone, but especially firefighters, to carry out their work," says Nolan. She says all firefighters, including those exposed to toxic chemicals on or after 9/11, are routinely monitored through annual physical and medical exams, and "decreases in their lungs' strength to inhale or blow out air are a sign of respiratory ill health."

Nolan says previous research has shown that nearly one in 10 firefighters exposed to dust at the WTC site is showing signs of lung injury. She says the WTC dust was laden with dangerous heavy metals, such as chromium and mercury, in addition to powdered concrete and toxic fibrous glass, asbestos, and components of jet fuel. When firefighters inhaled some of the dust at the disaster site, she says, it amounted to a slow chemical burning of their lung tissue that, in turn, led to chronic inflammation and lung injury.

For the current study, led by co-investigators George Crowley and Sophia Kwon, DO, MPH, the NYU Langone team analyzed blood levels of 580 metabolites frequently found in the body. All samples came from 9/11 firefighters who were tested within seven months of the disaster, and whose lung function has been tested annually ever since. Researchers matched 15 firefighters whose lung function had sharply declined by 2015 with 15 whose lung function had remained healthy, despite similar levels of exposure to WTC dust. Advanced computer software was then used to analyze the large volume of metabolite data.

When researchers plotted all metabolites on graphs, various chemical groups stood out as highly predictive of the majority of cases of OAD and lung injury.

Key among them were:

- decreases in sphingolipids, such as sphingosine 1-phosphate, a fat that has previously been linked to higher rates of asthma and found to trigger inflammation;
- declines in branched-chain amino acids, the building blocks of proteins, including leucine and valine, whose supplementation has in previous research been shown to counter chronic obstructive pulmonary disease

(COPD);

- increases in levels of stress hormones, especially vanillylmandelate, which may lead to elevated levels of fatty acids, potentially inducing inflammation.

Nolan says it is likely that metabolic imbalances contribute to the chronic inflammation that underlies most OAD and lung injury.

Can social media networks reduce political polarization on climate change? -- ScienceDaily

Social media networks, which often foster partisan antagonism, may also offer a solution to reducing political polarization, according to new findings published in the *Proceedings of the National Academy of Sciences* from a team led by University of Pennsylvania sociologist Damon Centola.

The Penn researchers asked 2,400 Republicans and Democrats to interpret recent climate-change data on Arctic sea-ice levels. Initially, nearly 40 percent of Republicans incorrectly interpreted the data, saying that Arctic sea-ice levels were increasing; 26 percent of Democrats made the same mistake. However, after participants interacted in anonymous social media networks -- sharing opinions about the data and its meaning for future levels of Arctic sea ice -- 88 percent of Republicans and 86 percent of Democrats correctly analyzed it, agreeing that sea-ice levels were dropping.

Republicans and Democrats who were not permitted to interact with each other in social media networks but instead had several additional minutes to reflect on the climate data before updating their responses remained highly polarized and offered significantly less accurate forecasts.

"New scientific information does not change people's minds. They can always interpret it to match their beliefs," says Centola, director of Penn's Network Dynamics Group and author of the new book "How Behavior Spreads." "But, if you allow people to interact with each other in egalitarian social networks, in which no individual is more powerful than another, we find remarkably strong effects of bipartisan social learning on eliminating polarization."

To test this notion for politically charged topics like climate change, Centola, along with Penn doctoral student Douglas Guilbeault and recent Penn Ph.D.

graduate Joshua Becker, constructed an experimental social media platform, which they used to test how different kinds of social media environments would affect political polarization and group accuracy.

Their study was motivated by NASA's 2013 release of new data detailing historical trends in monthly levels of Arctic sea ice. "NASA found, to its dismay, that a lot of people were misinterpreting the graph to say that there would actually be more Arctic sea ice in the future rather than less," Guilbeault explains. "Conservatives in particular were susceptible to this misinterpretation."

The researchers wondered how social media networks might alter this outcome, so they randomly assigned participants to one of three experimental groups: a political-identity setup, which revealed the political affiliation of each person's social media contacts; a political-symbols setup, in which people interacted anonymously through social networks but with party symbols of the donkey and the elephant displayed at the bottom of their screens; and a non-political setup, in which people interacted anonymously. Twenty Republicans and 20 Democrats made up each social network.

Once randomized, every individual then viewed the NASA graph and forecasted Arctic sea-ice levels for the year 2025. They first answered independently, and then viewed peers' answers before revising their guesses twice more. The study outcomes surprised the researchers in several respects.

"We all expected polarization when Republicans and Democrats were isolated," says Centola, who is also an associate professor in Penn's Annenberg School for Communication and School of Engineering and Applied Sciences, "but we were amazed to see how dramatically bipartisan networks could improve participants' judgments." In the non-political setup, for example, polarization disappeared entirely, with more than 85 percent of participants agreeing on a future decrease in Arctic sea ice.

"But," Centola adds, "the biggest surprise -- and perhaps our biggest lesson -- came from how fragile it all was. The improvements vanished completely with the mere suggestion of political party. All we did was put a picture of an elephant and a donkey at the bottom of a screen, and all the social learning effects disappeared. Participants' inaccurate beliefs and high levels of

polarization remained."

That last finding reveals that even inconspicuous elements of a social media environment or of a media broadcast can hinder bipartisan communications. "Simple ways of framing a political conversation, like incorporating political iconography, can significantly increase the likelihood of polarization," Guilbeault says.

Instead, Centola says, put people into situations that remove the political backdrop. "Most of us are biased in one way or another. It's often unavoidable. But, if you eliminate the symbols that drive people into their political camps and let them talk to each other, people have a natural instinct to learn from one another. And that can go a long way toward lessening partisan conflict."

Funding for the research came, in part, from the Social Sciences and Humanities Research Council of Canada, a Robert Wood Johnson Foundation Pioneer Grant, and the National Institutes of Health's Tobacco Centers for Regulatory Control.

Evolutionary origins of animal biodiversity -- ScienceDaily

A new study by an international team of researchers, led by scientists from the University of Bristol, has revealed the origins and evolution of animal body plans.

Animals evolved from unicellular ancestors, diversifying into thirty or forty distinct anatomical designs. When and how these designs emerged has been the focus of debate, both on the speed of evolutionary change, and the mechanisms by which fundamental evolutionary change occurs.

Did animal body plans emerge over eons of gradual evolutionary change, as Darwin suggested, or did these designs emerge in an explosive diversification episode during the Cambrian Period, about half a billion years ago?

The research team tackled this question by exhaustively compiling the presence and absence of thousands of features from all living animal groups.

Professor Philip Donoghue, from the University of Bristol's School of Earth Sciences, said: "This allowed us to create a 'shape space' for animal body plans, quantifying their similarities and differences.

"Our results show that fundamental evolutionary change was not limited to an early burst of evolutionary experimentation. Animal designs have continued to evolve to the present day -- not gradually as Darwin predicted -- but in fits and starts, episodically through their evolutionary history."

Co-author Bradley Deline, from the University of West Georgia (USA), added: "Our results are important in that they highlight the patterns and pathways in which animal body plans evolved.

"Moreover, major expansions in animal form following the Cambrian aligns with other major ecological transitions, such as the exploration of land.

"Many of the animals we are familiar with today are objectively bizarre compared with the Cambrian weird wonders. Frankly, butterflies and birds are stranger than anything swimming in the ancient sea."

Co-authors James Clark from Bristol's School of Earth Sciences and Dr Mark Puttick from the University of Bath's Department of Biology, worked on trying to fit fossil species into the study.

Dr Puttick said: "One of the problems we had is that our study is mostly based on living species and we needed to include fossils. We solved the problem through a combination of analyzing the fossils and using computer models of evolution."

James Clark added: "The fossils plot intermediate of their living relatives in shape space. This means that the distinctiveness of living groups is a consequence of the extinction of their evolutionary intermediates. Therefore, animals appear different because of their history rather than unpreserved jumps in anatomy."

Co-author Jenny Greenwood, also from the University of Bristol's School of Earth Sciences, wanted to dig deeper. She wanted to work out which of the many proposed genetic mechanisms drove the evolution of animal body plans.

Jenny said: "We did this by collecting data on the different genomes, proteins, and regulatory genes, that living animal groups possess. The differences in anatomical designs correlate with regulatory gene sets, but not the type or diversity of proteins. This indicates that it is the evolution of genetic regulation of embryology that precipitated the evolution of animal biodiversity."

Co-author Kevin Peterson from Dartmouth College (USA), added: "Our study confirms the view that continued gene regulatory construction was a key to animal evolution."

Story Source:

Materials provided by **University of Bristol**. *Note: Content may be edited for*

style and length.

Tracking marine migrations across geopolitical boundaries aids conservation -- ScienceDaily

The leatherback sea turtle is the largest living turtle and a critically endangered species. Saving leatherback turtles from extinction in the Pacific Ocean will require a lot of international cooperation, however, because the massive turtles may visit more than 30 different countries during their migrations.

A new study uses tracking data for 14 species of migratory marine predators, from leatherback turtles to blue whales and white sharks, to show how their movements relate to the geopolitical boundaries of the Pacific Ocean. The results provide critical information for designing international cooperative agreements needed to manage these species.

"If a species spends most of its time in the jurisdiction of one or two countries, conservation and management is a much easier issue than it is for species that migrate through many different countries," said Daniel Costa, professor of ecology and evolutionary biology at UC Santa Cruz and a coauthor of the study, published September 3 in *Nature Ecology & Evolution*.

"For these highly migratory species, we wanted to know how many jurisdictional regions they go through and how much time they spend in the open ocean beyond the jurisdiction of any one country," Costa said.

Under international law, every coastal nation can establish an exclusive economic zone (EEZ) extending up to 200 nautical miles from shore, giving it exclusive rights to exploit resources and regulate fisheries within that zone. The high seas beyond the EEZs are a global commons and are among the least protected areas on Earth. Discussions have been under way at the United Nations since 2016 to negotiate a global treaty for conservation and management of the high seas.

First author Autumn-Lynn Harrison, now at the Smithsonian Conservation Biology Institute in Washington, D.C., began the study as a graduate student in Costa's lab at UC Santa Cruz. Costa is a cofounder, with coauthor Barbara Block of Stanford University, of the Tagging of Pacific Predators (TOPP) program, which began tracking the movements of top ocean predators throughout the Pacific Ocean in 2000. Harrison wanted to use the TOPP data to address conservation issues, and as she looked at the data she began wondering how many countries the animals migrate through.

"I wanted to see if we could predict when during the year a species would be in the waters of a particular country," Harrison said. "Some of these animals are mostly hidden beneath the sea, so being able to show with tracking data which countries they are in can help us understand who should be cooperating to manage these species."

Harrison also began attending meetings on issues related to the high seas, which focused her attention on the time migratory species spend in these relatively unregulated waters. "Figuring out how much time these animals spend in the high seas was directly motivated by questions I was being asked by policy makers who are interested in high seas conservation," she said.

The TOPP data set, part of the global Census of Marine Life, is one of the most extensive data sets available on the movements of large marine animals. Many of the top predators in the oceans are declining or threatened, partly because their mobility exposes them to a wide array of threats in different parts of the ocean.

Leatherback turtle populations in the Pacific could face a 96 percent decline by 2040, according to the IUCN Red List of Threatened Species, and leatherbacks are a priority species for the National Oceanic and Atmospheric Administration (NOAA). Laysan and black-footed albatrosses, both listed as near threatened on the IUCN Red List, spend most of their time on the high seas, where they are vulnerable to being inadvertently caught on long lines during commercial fishing operations.

White sharks are protected in U.S. and Mexican waters, but the TOPP data show that they spend about 60 percent of their time in the high seas. Pacific bluefin tuna, leatherback turtles, Laysan albatross, and sooty shearwaters all

travel across the Pacific Ocean during their migrations.

"Bluefin tuna breed in the western North Pacific, then cross the Pacific Ocean to feed in the California Current off the United States and Mexico," Costa said. "Sooty shearwaters not only cross the open ocean, they use the entire Pacific Ocean from north to south and go through the jurisdictions of more than 30 different countries."

International cooperation has led to agreements for managing some of these migratory species, in some cases through regional fisheries management organizations. The Inter-American Tropical Tuna Commission (IATTC), for example, oversees conservation and management of tunas and other marine resources in the eastern Pacific Ocean.

The first session of a U.N. Intergovernmental Conference to negotiate an international agreement on the conservation of marine biological diversity beyond areas of national jurisdiction will be held in September. Harrison said she has already been asked to provide preprints and figures from the paper for this session.

"These migratory species are a shared heritage, and this paper shows their international travels better than ever before," Harrison said. "The first step to protect them is knowing where they are over their annual cycle and promoting international agreements to manage the threats they may face across several countries."

Scientists pioneer a new way to turn sunlight into fuel: New research in the field of semi-artificial photosynthesis -- ScienceDaily

The quest to find new ways to harness solar power has taken a step forward after researchers successfully split water into hydrogen and oxygen by altering the photosynthetic machinery in plants.

Photosynthesis is the process plants use to convert sunlight into energy. Oxygen is produced as by-product of photosynthesis when the water absorbed by plants is 'split'. It is one of the most important reactions on the planet because it is the source of nearly all of the world's oxygen. Hydrogen which is produced when the water is split could potentially be a green and unlimited source of renewable energy.

A new study, led by academics at St John's College, University of Cambridge, used semi-artificial photosynthesis to explore new ways to produce and store solar energy. They used natural sunlight to convert water into hydrogen and oxygen using a mixture of biological components and humanmade technologies.

The research could now be used to revolutionise the systems used for renewable energy production. A new paper, published in *Nature Energy*, outlines how academics at the Reisner Laboratory in Cambridge developed their platform to achieve unassisted solar-driven water-splitting.

Their method also managed to absorb more solar light than natural photosynthesis.

Katarzyna Sokól, first author and PhD student at St John's College, said: "Natural photosynthesis is not efficient because it has evolved merely to survive so it makes the bare minimum amount of energy needed -- around 1-2

per cent of what it could potentially convert and store."

Artificial photosynthesis has been around for decades but it has not yet been successfully used to create renewable energy because it relies on the use of catalysts, which are often expensive and toxic. This means it can't yet be used to scale up findings to an industrial level.

The Cambridge research is part of the emerging field of semi-artificial photosynthesis which aims to overcome the limitations of fully artificial photosynthesis by using enzymes to create the desired reaction.

Sokól and the team of researchers not only improved on the amount of energy produced and stored, they managed to reactivate a process in the algae that has been dormant for millennia.

She explained: "Hydrogenase is an enzyme present in algae that is capable of reducing protons into hydrogen. During evolution this process has been deactivated because it wasn't necessary for survival but we successfully managed to bypass the inactivity to achieve the reaction we wanted -- splitting water into hydrogen and oxygen."

Sokól hopes the findings will enable new innovative model systems for solar energy conversion to be developed.

She added: "It's exciting that we can selectively choose the processes we want, and achieve the reaction we want which is inaccessible in nature. This could be a great platform for developing solar technologies. The approach could be used to couple other reactions together to see what can be done, learn from these reactions and then build synthetic, more robust pieces of solar energy technology."

This model is the first to successfully use hydrogenase and photosystem II to create semi-artificial photosynthesis driven purely by solar power.

Dr Erwin Reisner, Head of the Reisner Laboratory, a Fellow of St John's College, University of Cambridge, and one of the paper's authors described the research as a 'milestone'.

He explained: ""This work overcomes many difficult challenges associated with the integration of biological and organic components into inorganic materials for the assembly of semi-artificial devices and opens up a toolbox for developing future systems for solar energy conversion."

Story Source:

Mud from the deep sea reveals clues about ancient monsoon -- ScienceDaily

Analyzing traces of leaf waxes from land plants that over millennia accumulated in deep sea sediments, a team of researchers led by the University of Arizona reconstructed the history of monsoon activity in northern Mexico. Their results, published online on Sept. 3 in the journal *Nature Geoscience*, help settle a long-standing debate over whether monsoon activity shut down completely under the influence of cooling brought about by the ice sheets that covered much of North America, or was merely suppressed.

During the Last Glacial Maximum, about 20,000 years ago, when mammoths and other prehistoric beasts roamed what is now northern Mexico and the southwestern United States, summer rains contributed a 35 percent of the annual rainfall, compared with about 70 percent today, according to the new study.

By diverting moisture from the tropics, the summer monsoon brings relief from months-long intense summer heat and drought to the arid lands of the American Southwest and northwestern Mexico. If the region depended on winter rains alone, the Sonoran Desert would not be known as one of the world's most biodiverse deserts.

"The monsoon is such an iconic feature of the desert Southwest, but we know very little about how it has changed over thousands and millions of years," says Tripti Bhattacharya, the study's first author. "Our finding that the Southwestern monsoon was suppressed, but not completely gone under glacial conditions, points to the dramatic variability of the atmospheric circulation at the time, but suggests it has been a persistent feature of our regional climate."

Previous studies had yielded inconclusive results, in part because the records used to infer evidence of past monsoon rainfall tend to be more like snapshots

in time rather than providing more continuous climate records. For example, researchers have gained valuable glimpses into long-vanished plant communities based on plant parts preserved in packrat nests called middens, or by analyzing the chemical signatures they left behind in soils. Those studies suggested persistent monsoon activity during the last ice age, whereas other studies based on climate modeling indicated it was temporarily absent.

By applying a clever method never before used to study the history of the monsoon, Bhattacharya and her co-authors discovered the equivalent of a forgotten, unopened book of past climate records, as opposed to previously studied climate archives, which in comparison are more like single, scattered pages.

Forming a vast natural vault almost 1,000 meters below the sea surface, the seafloor of oxygen-poor zones in the Gulf of California contains organic material blown into the water for many thousands of years, including debris from land plants growing in the region. Since the deposits remain largely undisturbed from scavengers or microbial activity, Tierney and her team were able to isolate leaf wax compounds from the seafloor mud.

Co-author Jessica Tierney, an associate professor in the UA's Department of Geosciences and Bhattacharya's former postdoctoral adviser, has pioneered the analysis of the waxy coatings of plant leaves to reconstruct rainfall or dry spells in the past based on their chemical fingerprint, specifically different ratios of hydrogen atoms. The water in monsoon rain, according to Tierney, contains a larger proportion of a hydrogen isotope known as deuterium, or "heavy water," which has to do with its origin in the tropics. Winter rains, on the other hand, carry a different signature because they contain water with a smaller ratio of deuterium versus "regular" hydrogen.

"Plants take up whichever water they get, and because the two seasons have different ratios of hydrogen isotopes, we can relate the isotope ratios in the preserved leaf waxes to the amount of monsoon rain across the Gulf of California region," Tierney explains.

Piecing together past patterns of the monsoon in the Southwest can help scientists better predict future scenarios under the influence of a climate that's trending toward a warmer world, not another ice age, the researchers say.

"The past is not a perfect analog, but it acts as a natural experiment that helps us test how well we understand the variability of regional climate," says Bhattacharya, who recently accepted a position as assistant professor of earth sciences at Syracuse University. "If we understand how regional climates responded in the past, it gives us a much better shot at predicting how they will respond to climate change in the future."

One way scientists can take advantage of past climate records is by applying climate models to them, using the records to "ground-truth" the models.

"The problem is that right now, our best climate models don't agree with regard to how the monsoon will change in response to global warming," Tierney says. "Some suggest the summer precipitation will become stronger, others say it'll get weaker. By better understanding the mechanics of the phenomenon, our results can help us figure out why the models disagree and provide constraints that can translate into the future."

To test the hypothesis of whether colder times generally weaken the monsoon and warmer periods strengthen it, Tierney's group is planning to investigate how the monsoon responded to warmer periods in the past. Future research will focus on the last interglacial period about 120,000 years ago, and a period marked by greenhouse gas levels similar to those in today's atmosphere: the Pliocene Epoch, which lasted from 5.3-2.5 million years ago.

Having better records of the Southwestern monsoon also helps scientists better understand how it compares to monsoons in other parts of the world that are better studied.

"We now know that our monsoon appears to be much more sensitive to the large-scale configuration of the atmosphere, whereas other monsoon systems are tied more closely to local ocean conditions," Bhattacharya says.

Chaos-inducing genetic approach stymies antibiotic-resistant superbugs -- ScienceDaily

A genetic disruption strategy developed by University of Colorado Boulder researchers effectively stymies the evolution of antibiotic-resistant bacteria such as *E. coli*, giving scientists a crucial leg up in the ongoing battle against deadly superbugs.

These multidrug-resistant pathogens -- which adapt to current antibiotics faster than new ones can be created -- infect nearly 2 million people and cause at least 23,000 deaths annually in the U.S., according to data from the Centers for Disease Control.

In an effort to develop a sustainable long-term solution, CU Boulder researchers created the Controlled Hindrance of Adaptation of OrganismS (CHAOS) approach, which uses CRISPR DNA editing techniques to modify multiple gene expressions within the bacteria cells, stunting the pathogen's central processes and thwarting its ability to evolve defenses.

"We now have a way to cut off the evolutionary pathways of some of the nastiest bugs and potentially prevent future bugs from emerging at all," said Peter Otoupal, lead author of the study and a doctoral researcher in CU Boulder's Department of Chemical and Biological Engineering (CHBE).

The CHAOS research is the culmination of work that began in 2013, when Otoupal and his colleagues began searching for genes that could act as a cellular kill switch for *E. coli*. When the scientists tweaked one gene at a time, the bacteria could adapt and survive. But when they altered two or more genes at once, the cell got weaker.

"We saw that when we tweaked multiple gene expressions at the same time -- even genes that would seemingly help the bacteria survive -- the bacteria's

fitness dropped dramatically," Otoupal said.

The CHAOS method takes advantage of this effect, pulling multiple genetic levers in order to build up stress on the bacterial cell and eventually trigger a cascading failure, leaving the bug more vulnerable to current treatments. The technique does not alter the bug's DNA itself, only the expression of individual genes, similar to the way a coded message is rendered useless without the proper decryption.

"You can think of it in terms of a series of escalating annoyances to the cell that eventually cause it to weaken," said Anushree Chatterjee, senior author of the study and an assistant professor in CHBE. "This method offers tremendous potential to create more effective combinatorial approaches."

Although *E. coli* has nearly 4,000 individual genes, the exact gene modification sequence appears to matter less than the sheer number of genes that are disrupted, Otoupal said. Still, the researchers plan to continue optimizing the CHAOS method to seek out the most efficient disruptions.

The findings are outlined today in the journal Nature *Communications Biology* and could open new research avenues on how to best restrict a pathogen's antibiotic resistance.

"Diseases are very dynamic, so we need to design smarter therapies that can gain control over their rapid adaptation rates," Chatterjee said. "The emphasis in our lab is demonstrating the efficacy of these methods and then finding ways to translate the technology to modern clinical settings."

"In the past, nobody really considered that it might be possible to slow down evolution," Otoupal said. "But like anything else, evolution has rules and we're starting to learn how to use them to our advantage."

Story Source:

Materials provided by **University of Colorado at Boulder**. Original written by Trent Knoss. *Note: Content may be edited for style and length.*

8,000 new antibiotic combinations are surprisingly effective: Grouping 4 or 5 existing medications could help slow antibiotic-resistant bacteria -- ScienceDaily

Scientists have traditionally believed that combining more than two drugs to fight harmful bacteria would yield diminishing returns. The prevailing theory is that that the incremental benefits of combining three or more drugs would be too small to matter, or that the interactions among the drugs would cause their benefits to cancel one another out.

Now, a team of UCLA biologists has discovered thousands of four- and five-drug combinations of antibiotics that are more effective at killing harmful bacteria than the prevailing views suggested. Their findings, reported today in the journal *npj Systems Biology and Applications*, could be a major step toward protecting public health at a time when pathogens and common infections are increasingly becoming resistant to antibiotics.

"There is a tradition of using just one drug, maybe two," said Pamela Yeh, one of the study's senior authors and a UCLA assistant professor of ecology and evolutionary biology. "We're offering an alternative that looks very promising. We shouldn't limit ourselves to just single drugs or two-drug combinations in our medical toolbox. We expect several of these combinations, or more, will work much better than existing antibiotics."

Working with eight antibiotics, the researchers analyzed how every possible four- and five-drug combination, including many with varying dosages -- a total of 18,278 combinations in all -- worked against *E. coli*. They expected that some of the combinations would be very effective at killing the bacteria, but they were startled by how many potent combinations they discovered.

For every combination they tested, the researchers first predicted how

effective they thought it would be in stopping the growth of *E. coli*. Among the four-drug combinations, there were 1,676 groupings that performed better than they expected. Among the five-drug combinations, 6,443 groupings were more effective than expected.

"I was blown away by how many effective combinations there are as we increased the number of drugs," said Van Savage, the study's other senior author and a UCLA professor of ecology and evolutionary biology and of biomathematics. "People may think they know how drug combinations will interact, but they really don't."

On the other hand, 2,331 four-drug combinations and 5,199 five-drug combinations were less effective than the researchers expected they would be, said Elif Tekin, the study's lead author, who was a UCLA postdoctoral scholar during the research.

Some of the four- and five-drug combinations were effective at least partly because individual medications have different mechanisms for targeting *E. coli*. The eight tested by the UCLA researchers work in six unique ways.

"Some drugs attack the cell walls, others attack the DNA inside," Savage said. "It's like attacking a castle or fortress. Combining different methods of attacking may be more effective than just a single approach."

Said Yeh: "A whole can be much more, or much less, than the sum of its parts, as we often see with a baseball or basketball team." (As an example, she cited the decisive upset victory in the 2004 NBA championship of the Detroit Pistons -- a cohesive team with no superstars -- over a Los Angeles Lakers team with future Hall of Famers Kobe Bryant, Shaquille O'Neal, Karl Malone and Gary Payton.)

Yeh added that although the results are very promising, the drug combinations have been tested in only a laboratory setting and likely are at least years away from being evaluated as possible treatments for people.

"With the specter of antibiotic resistance threatening to turn back health care to the pre-antibiotic era, the ability to more judiciously use combinations of existing antibiotics that singly are losing potency is welcome," said Michael

Kurilla, director of the Division of Clinical Innovation at the National Institutes of Health/National Center for Advancing Translational Sciences. "This work will accelerate the testing in humans of promising antibiotic combinations for bacterial infections that we are ill-equipped to deal with today."

The researchers are creating open-access software based on their work that they plan to make available to other scientists next year. The software will enable other researchers to analyze the different combinations of antibiotics studied by the UCLA biologists, and to input data from their own tests of drug combinations.

Using a MAGIC framework

One component of the software is a mathematical formula for analyzing how multiple factors interact, which the UCLA scientists developed as part of their research. They call the framework "mathematical analysis for general interactions of components," or MAGIC.

"We think MAGIC is a generalizable tool that can be applied to other diseases -- including cancers -- and in many other areas with three or more interacting components, to better understand how a complex system works," Tekin said.

Savage said he plans to use concepts from that framework in his ongoing research on how temperature, rain, light and other factors affect the Amazon rainforests.

He, Yeh and Mirta Galesic, a professor of human social dynamics at the Santa Fe Institute, also are using MAGIC in a study of how people's formation of ideas is influenced by their parents, friends, schools, media and other institutions -- and how those factors interact.

"It fits in perfectly with our interest in interacting components," Yeh said.

Other co-authors of the new study are Cynthia White, a UCLA graduate who was a research technician while working on the project; Tina Kang, a UCLA doctoral student; Nina Singh, a student at the University of Southern

California; Mauricio Cruz-Loya, a UCLA doctoral student; and Robert Damoiseaux, professor of molecular and medical pharmacology, and director of UCLA's Molecular Screening Shared Resource, a facility with advanced robotics technology where Tekin, White, and Kang conducted much of the research.

The research team reported in 2016 that combinations of three antibiotics can often overcome bacteria's resistance to antibiotics, even when none of the three antibiotics on its own -- or even two of the three together -- is effective. The biologists reported in 2017 two combinations of drugs that are unexpectedly successful in reducing the growth of *E. coli* bacteria.

A new way to remove ice buildup without power or chemicals: Passive solar-powered system could prevent freezing on airplanes, wind turbines, powerlines, and other surfaces -- ScienceDaily

From airplane wings to overhead powerlines to the giant blades of wind turbines, a buildup of ice can cause problems ranging from impaired performance all the way to catastrophic failure. But preventing that buildup usually requires energy-intensive heating systems or chemical sprays that are environmentally harmful. Now, MIT researchers have developed a completely passive, solar-powered way of combating ice buildup.

The system is remarkably simple, based on a three-layered material that can be applied or even sprayed onto the surfaces to be treated. It collects solar radiation, converts it to heat, and spreads that heat around so that the melting is not just confined to the areas exposed directly to the sunlight. And, once applied, it requires no further action or power source. It can even do its de-icing work at night, using artificial lighting.

The new system is described today in the journal *Science Advances*, in a paper by MIT associate professor of mechanical engineering Kripa Varanasi and postdocs Susmita Dash and Jolet de Ruiter.

"Icing is a major problem for aircraft, for wind turbines, powerlines, offshore oil platforms, and many other places," Varanasi says. "The conventional ways of getting around it are de-icing sprays or by heating, but those have issues."

Inspired by the sun

The usual de-icing sprays for aircraft and other applications use ethylene

glycol, a chemical that is environmentally unfriendly. Airlines don't like to use active heating, both for cost and safety reasons. Varanasi and other researchers have investigated the use of superhydrophobic surfaces to prevent icing passively, but those coatings can be impaired by frost formation, which tends to fill the microscopic textures that give the surface its ice-shedding properties.

As an alternate line of inquiry, Varanasi and his team considered the energy given off by the sun. They wanted to see, he says, whether "there is a way to capture that heat and use it in a passive approach." They found that there was.

It's not necessary to produce enough heat to melt the bulk of the ice that forms, the team found. All that's needed is for the boundary layer, right where the ice meets the surface, to melt enough to create a thin layer of water, which will make the surface slippery enough so any ice will just slide right off. This is what the team has achieved with the three-layered material they've developed.

Layer by layer

The top layer is an absorber, which traps incoming sunlight and converts it to heat. The material the team used is highly efficient, absorbing 95 percent of the incident sunlight, and losing only 3 percent to re-radiation, Varanasi says

In principle, that layer could in itself help to prevent frost formation, but with two limitations: It would only work in the areas directly in sunlight, and much of the heat would be lost back into the substrate material -- the airplane wing or powerline, for example -- and would not help with the de-icing.

So, to compensate for the localization, the team added a spreader layer -- a very thin layer of aluminum, just 400 micrometers thick, which is heated by the absorber layer above it and very efficiently spreads that heat out laterally to cover the entire surface. The material was selected to have "thermal response that is fast enough so that the heating takes place faster than the freezing," Varanasi says.

Finally, the bottom layer is simply foam insulation, to keep any of that heat from being wasted downward and keep it where it's needed, at the surface.

"In addition to passive de-icing, the photothermal trap stays at an elevated temperature, thus preventing ice build-up altogether," Dash says.

The three layers, all made of inexpensive commercially available material, are then bonded together, and can be bonded to the surface that needs to be protected. For some applications, the materials could instead be sprayed onto a surface, one layer at a time, the researchers say.

The team carried out extensive tests, including real-world outdoor testing of the materials and detailed laboratory measurements, to prove the effectiveness of the system.

The system could even find wider commercial uses, such as panels to prevent icing on roofs of homes, schools, and other buildings, Varanasi says. The team is planning to continue work on the system, testing it for longevity and for optimal methods of application. But the basic system could essentially be applied almost immediately for some uses, especially stationary applications, he says.

Cryptosporidiosis worsened in mice on probiotics -- ScienceDaily

As compared to control mice, the probiotic-consuming mice excreted more parasites in their feces, and their intestinal microflora were different from those of the control mice. However, both sets of microflora were composed of genera that normally are present in the gut, and the mechanisms responsible for the observed probiotic effect are unclear, said corresponding author, Giovanni Widmer, PhD, whose graduate student, Bruno Oliveira, ran the experiments.

Contrary to expectations, "we found that consumption of a commercially available probiotic actually increased the severity of the infection," said Dr. Widmer, who is Professor of Infectious Disease & Global Health, Cummings School of Veterinary Medicine, Tufts University, North Grafton, MA.

Cryptosporidiosis is a major cause of infant diarrhea in developing nations. It killed an estimated 48,000 people worldwide in 2016, and caused the loss of more than 4.2 million disability-adjusted life-years, according to The Lancet, a medical journal. There are neither drugs to treat cryptosporidiosis, nor vaccines to prevent it. (image: high magnification micrograph of cryptosporidium infection, Wikimedia Commons)

Antibiotics, which often perturb or even deplete the normal intestinal microbiota, can thus render individuals more vulnerable to intestinal infections. Conversely, a healthy microbiome can prevent such infections, or reduce their severity. Reasoning along these lines, the researchers posited that a probiotic containing live microorganisms that are found in healthy intestines could reduce the severity of cryptosporidiosis in a mouse model.

"Mitigating the disease's severity may be sufficient to prevent diarrhea, or shorten its duration, and enable the immune system to naturally control the infection," said Dr. Widmer.

Despite an outcome that was contrary to the working hypothesis, the results demonstrate that it may be possible to develop probiotics to mitigate cryptosporidiosis. Prior to the experiment, "we didn't know if cryptosporidium growth in the gut could be affected by diet," said Dr. Widmer. "The goal is now to find a mechanistic link between microflora and cryptosporidium proliferation, and ultimately design a simple nutritional supplement which helps the body fight the infection."

"Identifying specific mechanisms that alter pathogen virulence in response to diet may enable the development of simple pre- or probiotics capable of modifying the composition of the microbiota to reduce the severity of cryptosporidiosis," said Dr. Widmer.

Story Source:

Materials provided by **American Society for Microbiology**. *Note: Content may be edited for style and length.*

Eating in 10-hour window can override disease-causing genetic defects, nurture health: Periods of fasting can protect against obesity and diabetes -- ScienceDaily

Scientists at the Salk Institute found that mice lacking the biological clocks thought to be necessary for a healthy metabolism could still be protected against obesity and metabolic diseases by having their daily access to food restricted to a 10-hour window.

The work, which appeared in the journal *Cell Metabolism* on August 30, 2018, suggests that the health problems associated with disruptions to animals' 24-hour rhythms of activity and rest -- which in humans is linked to eating for most of the day or doing shift work -- can be corrected by eating all calories within a 10-hour window.

"For many of us, the day begins with a cup of coffee first thing in the morning and ends with a bedtime snack 14 or 15 hours later," says Satchidananda Panda, a professor in Salk's Regulatory Biology Laboratory and the senior author of the new paper. "But restricting food intake to 10 hours a day, and fasting the rest, can lead to better health, regardless of our biological clock."

Every cell in mammals' bodies operates on a 24-hour cycle known as the circadian rhythm -- cellular cycles that govern when various genes are active. For example, in humans, genes for digestion are more active earlier in the day while genes for cellular repair are more active at night. Previously, the Panda lab discovered that mice allowed 24-hour access to a high-fat diet became obese and developed a slew of metabolic diseases including high cholesterol, fatty liver and diabetes. But these same mice, when restricted to the high-fat diet for a daily 8- to 10-hour window became lean, fit and healthy. The lab attributed the health benefits to keeping the mice in better sync with their

cellular clocks -- for example, by eating most of the calories when genes for digestion were more active.

In the current study, the team aimed to better understand the role of circadian rhythms in metabolic diseases by disabling genes responsible for maintaining the biological clock in mice, including in the liver, which regulates many metabolic functions. The genetic defects in these clock-less mice make them prone to obesity, diabetes, fatty liver disease and elevated blood cholesterol. These diseases further escalate when the animals are allowed to eat fatty and sugary food.

To test whether time-restricted eating could benefit these "clock-less" mice, Panda's team put them on one of two high-fat diet regimes: one group had access to food around the clock, the other had access to the same number of calories only during a 10-hour window. As the team expected, the group that could eat at any time became obese and developed metabolic diseases. But the group that ate the same number of calories within a 10-hour window remained lean and healthy -- despite not having an internal "biological clock" and thereby genetically programmed to be morbidly sick. This told the researchers that the health benefits from a 10-hour window were not just due to restricting eating to times when genes for digestion were more active.

"From the previous study, we had been under the impression that the biological clock was internally timing the process of turning genes for metabolism on and off at predetermined times," says Amandine Chaix, a staff scientist at Salk and the paper's first author. "And while that may still be true, this work suggests that by controlling the animals' feeding and fasting cycles, we can basically override the lack of an internal timing system with an external timing system."

According to the researchers, the new work suggests that the primary role of circadian clocks may be to tell the animal when to eat and when to stay away from food. This internal timing strikes a balance between sufficient nutrition during the fed state and necessary repair or rejuvenation during fasting. When this circadian clock is disrupted, as when humans do shift work, or when it is compromised due to genetic defects, the balance between nutrition and rejuvenation breaks down and diseases set in.

As we age, our circadian clocks weaken. This age-dependent deterioration of circadian clock parallels our increased risk for metabolic diseases, heart diseases, cancer and dementia.

But the good news, say the researchers, is that a simple lifestyle such as eating all food within 10 hours can restore balance, stave off metabolic diseases and maintain health. "Many of us may have one or more disease-causing defective genes that make us feel helpless and destined to be sick. The finding that a good lifestyle can beat the bad effects of defective genes opens new hope to stay healthy," says Panda.

The lab next plans to study whether eating within 8-10 hours can prevent or reverse many diseases of aging, as well as looking at how the current study could apply to humans. Their website, mycircadianclock.org, allows people anywhere in the world to sign up for studies, download an app and get guidance on how to adopt an optimum daily eating-fasting cycle. By collecting daily eating and health status data from thousands of people, the lab hopes to gain a better understanding of how a daily eating-fasting cycle sustains health.

Story Source:

Materials provided by **Salk Institute**. *Note: Content may be edited for style and length.*

Are vulnerable lions eating endangered zebras? New study looks at whether a recovering predator is causing another species to decline -- ScienceDaily

That's what a team of researchers led by WCS and WWF set out to discover -- whether the comeback of a top predator -- in this case lions in Laikipa County, Kenya -- were recovering at the expense of Grevy's zebras, which number only around 2,680 individuals with half of those living in Likipia.

In recent years, lion numbers have slowly recovered in this region as livestock ranching -- which commonly practiced shooting or poisoning lions -- has given way to wildlife tourism. Lions (*Panthera leo*) are classified as Threatened by IUCN.

Publishing their results in the journal *PLOS ONE*, the team used satellite telemetry to track the movements of both lions and zebras.

The team found that lions preyed on both Grevy's and plains zebras (*Equus quagga*) far less than expected. Their data showed that the population of Grevy's zebra populations may in fact be stabilizing with recruitment into the population tripling since 2004.

The researchers did conclude that competitive displacement by livestock and interference competition for grass from plains zebras, which are 22 times more abundant than Grevy's, are most likely the predominant threat to Grevy's zebras' recovery.

Story Source:

Materials provided by **Wildlife Conservation Society**. *Note: Content may be edited for style and length.*

Allergists warn that chigger bites may cause allergic reaction to red meat -- ScienceDaily

Chiggers, redbugs, harvest mites -- whatever you call them, they are pesky little bugs whose bites cause really itchy rashes, usually around the ankles and waistline.

In addition to being uncomfortable and annoying, these bites may also cause a relatively rare allergic reaction to red meat known as alpha-gal, according to doctors at Wake Forest Baptist Medical Center.

Although the medical community has known for the past five to 10 years that ticks can cause this allergy, case studies from Wake Forest Baptist and the University of Virginia (U.Va.) suggest that chigger bites also may be responsible. The paper is published in the current issue of *The Journal of Allergy and Clinical Immunology: In Practice*.

"If a patient comes in telling me they ate red meat for dinner and then hours later woke up with anaphylaxis, I suspect an alpha-gal allergy," said lead author Russell Scott Traister, M.D., Ph.D., assistant professor of pulmonary, critical care, allergy and immunologic diseases at Wake Forest Baptist.

"With those symptoms, doctors usually ask if the person has had a tick bite recently. But we started seeing patients with the same symptoms who said they hadn't had a tick bite, only chigger bites."

This allergy is a reaction to a carbohydrate molecule on mammalian meat -- beef, pork, venison, etc. -- called alpha-gal. However, unlike most allergic reactions that happen within minutes, a reaction to alpha-gal occurs after three to six hours. The only cure is to avoid all mammalian meat, Traister said.

In addition to case studies seen at Wake Forest Baptist, Traister cited results reported by U.Va. from 311 patients who had answered a questionnaire about

exposure to tick or chigger bites before developing an alpha-gal allergy. Of the 301 who reported either tick or chigger bites in the past 10 years, 5.5 percent reported a history of chigger bites, but no tick exposure.

Further studies are needed to determine if the alpha-gal molecule is in the gastrointestinal tracts of chiggers to confirm that they, as well as ticks, can cause mammalian meat allergy.

"In the meantime, we want allergists to be aware that patients may report chigger bites, and based on that fact alone should not dismiss alpha-gal sensitization as a possible diagnosis," Traister said.

Story Source:

Materials provided by **Wake Forest Baptist Medical Center**. *Note: Content may be edited for style and length.*

A computational analysis identifies a new clinical phenotype of severe malaria: The results of the study could help reduce malaria-associated mortality -- ScienceDaily

There are more clinical phenotypes of severe malaria than those defined by the World Health Organization (WHO), according to a study led by ISGlobal, an institution supported by "la Caixa" Foundation. The results indicate that heart failure can be a pathogenic mechanism of disease, which has implications in the clinical management of these patients.

Despite the progress achieved over the last decades, malaria is estimated to have caused almost half a million deaths in 2016, mostly among children. The definition of severe malaria was established to identify those children at risk of dying, but in reality it is a complex and heterogeneous disease that not always responds to the recommended treatments.

The team led by Climent Casals-Pascual, researcher at ISGlobal and at Oxford University, applied a computational analysis based on networks in order to identify biologically relevant phenotypes apart from those currently defined by the WHO (cerebral malaria, respiratory distress, and severe malarial anaemia). For this, they performed a 'network-based clustering analysis' with data from almost 3,000 Gambian children hospitalized with malaria. They found that the mortality was higher in those clusters with higher phenotypic heterogeneity. The analysis revealed four clusters of patients with both respiratory distress and severe anaemia, in which an increase in liver size was associated with higher mortality. By analysing plasma proteins of these patients, they showed that this is likely due to heart failure.

"Our results indicate that heart failure should be reconsidered as a pathogenic mechanism in severe malaria," explains Casals-Pascual, "and that therefore

the standard clinical management may not be appropriate for these patients." This type of "systems approach" can be a very valuable tool to identify new phenotypes and mechanisms as well as therapeutic options for complex diseases," he adds.

Story Source:

Materials provided by **Barcelona Institute for Global Health (ISGlobal)**.
Note: Content may be edited for style and length.

Synthetic microbiome? Genetic engineering allows different species of bacteria to communicate -- ScienceDaily

More than 1,000 species of bacteria have been identified in the human gut, and understanding this incredibly diverse "microbiome" that can greatly impact health and disease is a hot topic in scientific research. Because bacteria are routinely genetically engineered in science labs, there is great excitement about the possibility of tweaking the genes of our intestinal interlopers so that they can do more than just help digest our food (e.g., record information about the state of the gut in real-time, report the presence of disease, etc.). However, little is known about how all those different strains communicate with each other, and whether it is even possible to create the kinds of signaling pathways that would allow information to be passed between them.

Now, researchers from the Wyss Institute at Harvard University, Harvard Medical School (HMS), and Brigham and Women's Hospital have successfully engineered a genetic signal-transmission system in which a molecular signal sent by Salmonella Typhimurium bacteria in response to an environmental cue can be received and recorded by *E. coli* in the gut of a mouse, bringing scientists a step closer to developing a "synthetic microbiome" composed of bacteria that are programmed to perform specific functions. The study is reported in *ACS Synthetic Biology*.

"In order to improve human health through engineered gut bacteria, we need to start figuring out how to make the bacteria communicate," said Suhyun Kim, a graduate student in the lab of Pamela Silver at the Wyss Institute and HMS, who is the first author of the paper. "We want to make sure that, as engineered probiotics develop, we have a means to coordinate and control them in harmony."

The team harnessed an ability that naturally occurs in some strains of bacteria

called "quorum sensing," in which the bacteria send and receive signal molecules that indicate the overall density of the bacterial colony and regulate the expression of many genes involved in group activities. A particular type of quorum sensing known as acyl-homoserine lactone (acyl-HSL) sensing has not yet been observed in the mammalian gut, so the team decided to see if they could repurpose its signaling system to create a bacterial information transfer system using genetic engineering.

The researchers introduced two new genetic circuits into different colonies of a strain of *E. coli* bacteria: a "signaler" circuit, and a "responder" circuit. The signaler circuit contains a single copy of a gene called luxI that is turned on by the molecule anhydrotetracycline (ATC) and produces a quorum-sensing signaling molecule. The responder circuit is structured such that when the signaling molecule binds to it, a gene called cro is activated to produce the protein Cro, which then turns on a "memory element" within the responder circuit. The memory element expresses two additional genes: LacZ and another copy of cro. The expression of LacZ causes the bacterium to turn blue if plated on a special agar, thus producing visual confirmation that the signal molecule has been received. The extra copy of cro forms a positive feedback loop that keeps the memory element on, ensuring that the bacterium continues to express LacZ over an extended period of time.

The researchers confirmed that this system works in vitro in both *E. coli* and *S. Typhimurium* bacteria, observing that the responder bacteria turned blue when ATC was added to the signaler bacteria. To see if it would work in vivo, they administered both signaler and responder *E. coli* bacteria to mice, and then gave the mice ATC in their drinking water for two days. When fecal samples from the mice were analyzed, over half of the mice displayed clear signs of 3OC6HSL signal transmission that persisted after two days on ATC.

"It was exciting and promising that our system, with single copy-based circuits, can create functional communication in the mouse gut," explained Kim. "Traditional genetic engineering introduces multiple copies of a gene of interest into the bacterial genome via plasmids, which places a high metabolic burden on the engineered bacteria and causes them to be easily outcompeted by other bacteria in the host."

Finally, the team repeated the in vivo experiment, but gave the mice signaler

S. Typhimurium bacteria and *E. coli* responder bacteria, to see if the signal could be transmitted across different species of bacteria within the mouse's gut. All mice displayed signs of signal transmission, confirming that the engineered circuits allowed communication between different species of bacteria in the complex environment of the mammalian gut.

The researchers hope to continue this line of inquiry by engineering more species of bacteria so that they can communicate, and by searching for and developing other signaling molecules that can be used to transmit information between them.

"Ultimately, we aim to create a synthetic microbiome with completely or mostly engineered bacteria species in our gut, each of which has a specialized function (e.g., detecting and curing disease, creating beneficial molecules, improving digestion, etc.) but also communicates with the others to ensure that they are all balanced for optimal human health," said corresponding author Silver, Ph.D., a Founding Core Faculty member of the Wyss Institute who is also the Elliot T. and Onie H. Adams Professor of Biochemistry and Systems Biology at HMS.

"The microbiome is the next frontier in medicine as well as wellness. Devising new technologies to engineer intestinal microbes for the better while appreciating that they function as part of a complex community, as was done here, represents a major step forward in this direction," said Wyss Founding Director Donald Ingber, M.D., Ph.D., who is also the Judah Folkman Professor of Vascular Biology at HMS and the Vascular Biology Program at Boston Children's Hospital, as well as Professor of Bioengineering at SEAS.

Mechanism of Marburg virus sexual transmission identified in nonhuman primates -- ScienceDaily

Research published today by a team of Army scientists sheds light on the mechanism of sexual transmission of filoviruses, including Ebola and Marburg virus, which have been shown to persist in the testes and other immune privileged sites. Their work appears online in the journal *Cell Host and Microbe*.

Sexual transmission of filoviruses was first reported in 1968 after an outbreak of Marburg virus disease and recently caused flare-ups of Ebola virus disease in the 2013-2016 outbreak, according to the authors. How filoviruses establish testicular persistence and are shed in semen, however, was unknown.

Led by Dr. Xiankun (Kevin) Zeng, investigators at the U.S. Army Medical Research Institute of Infectious Diseases (USAMRIID) conducted a study using cynomolgus macaques to examine the persistence of Marburg virus in the testes of animals that survived infection after being treated with antiviral compounds.

The team found that Marburg virus persists in the seminiferous tubules, which are the sites of immune privilege and sperm production in the testes. Persistence leads to severe testicular damage, including cell depletion and breakdown of the blood-testis barrier, according to the authors. In addition, they identified a type of specialized cells, known as the Sertoli cells, as the reservoir for the Marburg virus.

"Importantly, we also identified local infiltration of immunosuppressive regulatory T cells, which may play an important role in sustaining Marburg virus persistence," said Zeng. "Targeting these T cells may help to clear Marburg virus from the testes, thereby preventing sexual transmission of the

virus."

About 30 percent of cynomolgus monkeys that survived Marburg virus infection after antiviral treatment had persistent Marburg virus infection in the testes, but not in other common target organs such as the liver, spleen, and lymph nodes, according to the authors. The fact that it takes longer for Marburg virus to infect the testes strongly suggests that early intervention with therapeutics can prevent testicular persistence.

The 2013-2016 outbreak of Ebola virus disease in Western Africa resulted in about 11,000 deaths, and left behind the biggest cohort (over 17,000 individuals) of Ebola survivors in history, according to the World Health Organization. Many follow-up studies have detected Ebola virus RNA in the semen of survivors up to 18 months after recovery.

"Sexual transmission of Ebola virus has been implicated in the initiation of entirely new transmission chains," Zeng explained. "Our study illustrates the mechanism behind testicular filovirus persistence and sexual transmission of filoviruses."

According to Zeng, the team's next step is to develop animal models to evaluate the efficacy of medical countermeasures to prevent and clear Marburg and Ebola viral persistence in the testes.

Story Source:

Materials provided by **US Army Medical Research Institute of Infectious Diseases**. *Note: Content may be edited for style and length.*

Using physics to predict crowd behavior -- ScienceDaily

Electrons whizzing around each other and humans crammed together at a political rally don't seem to have much in common, but researchers at Cornell are connecting the dots.

They've developed a highly accurate mathematical approach to predict the behavior of crowds of living creatures, using Nobel Prize-winning methods originally developed to study large collections of quantum mechanically interacting electrons. The implications for the study of human behavior are profound, according to the researchers.

For example, by using publicly available video data of crowds in public spaces, their approach could predict how people would distribute themselves under extreme crowding. By measuring density fluctuations using a smartphone app, the approach could describe the current behavioral state or mood of a crowd, providing an early warning system for crowds shifting toward dangerous behavior.

Tomas Arias, professor of physics, is lead author of "Density-Functional Fluctuation Theory of Crowds," which published Aug. 30 in *Nature Communications*. Co-authors include Itai Cohen, professor of physics; and Yunus A. Kinkhabwala, a doctoral student in the field of engineering.

Interactions among individuals in a crowd can be complex and difficult to quantify mathematically; the large number of actors in a crowd results in a complex mathematical problem. The researchers sought to predict the behavior of crowds by using simple measurements of density to infer underlying interactions and to use those interactions to predict new behaviors.

To achieve this, they applied mathematical concepts and approaches from density-functional theory (DFT), a branch of many-body physics developed for quantum mechanical systems, to the behavior of crowds.

"This is one of the all-too-rare cases -- particularly where living systems are involved -- where the theory preceded the experiments, and the experiments, in precise mathematical detail, completely confirmed the theory," said Arias.

To test their theory, the researchers created a model system using walking fruit flies (*Drosophila melanogaster*). They first demonstrated a mathematical way to extract functions that quantify how much the flies like different locations in their environment -- the "vexation" function -- and how much they mind crowding together -- the "frustration" function based on the details of how the population densities change as the flies more around.

They then showed that by mixing and matching this information with observations of a single fly in an entirely new environment, they could accurately predict, before any observations, how a large crowd of flies would distribute themselves in that new environment. They also tracked changes in the overall behavior of the crowd -- i.e., its "mood" -- by tracking evolution of the social preference "frustration" function.

While fruit flies were "a convenient, and ethical, first test system," Arias said, the behavior of a crowd at a political rally would provide a human example of DFT theory. Individuals will try to find the best location to stand -- typically closest to the stage -- while avoiding overcrowded areas. When new and better locations become available, individuals are likely to move toward them.

To develop a mathematically predictive theory, the researchers associated a number -- the vexation function -- with the intrinsic desirability of each location; the lowest value would be at the ideal location, closest to the stage. The frustration function accounts for the undesirability of crowding effects, and a behavioral rule accounts for the tendency of individuals to look for better locations.

"The remarkable mathematical discovery," Arias said, "is that precise values for vexation and frustration can be obtained instantly and automatically, simply by observing changes in crowding as the crowd mills around, without the need for any kind of survey to ask people in the crowd how they feel about different locations or crowding together."

By varying the social circumstances in their fly experiments -- such as changing the ratio of male and female, or inducing hunger and thirst -- and monitoring the frustration values of the crowd, the researchers showed they can detect changes in the "mood" of the crowd. The DFT approach, therefore, not only predicts crowd behaviors under new circumstances, but also can be used to quickly and automatically detect changes in social behaviors.

Another application, using cell-phone and census data, could analyze political or economic drivers and population pressures to describe and predict large-scale population flows, such as mass migrations. "The resulting predictions of migration during acute events would enable better planning by all levels of government officials, from local municipalities to international bodies, with the potential to save millions of human lives," note the researchers.

Other contributors included J. Felipe Méndez-Valderrama, professor of physics, University of Los Andes, Bogota, Colombia; and Jeffrey Silver, senior analyst at Metron Inc.

Countries ranked by oil production emissions -- ScienceDaily

Until renewable sources of energy like wind or solar become more reliable and less expensive, people worldwide remain reliant on fossil fuels for transportation and energy. This means that if people want to reduce greenhouse gas emissions, there need to be better ways of mitigating the effects of extracting and burning oil and gas.

Now, Adam Brandt, assistant professor of energy resources engineering in the School of Earth, Energy & Environmental Sciences at Stanford, and his colleagues have performed a first global analysis comparing emissions associated with oil production techniques -- a step toward developing policies that could reduce those emissions. They published their work Aug. 30 in *Science*.

The group found that the burning of unwanted gas associated with oil production -- called flaring -- remains the most carbon-intensive part of producing oil. Brandt spoke with *Stanford Report* about the group's findings and strategies for reducing flaring.

What is flaring and why is it especially important to track?

Oil and gas are generally produced together. If there are nearby gas pipelines, then power plants, factories, businesses and homes can consume the gas. However, if you're very far offshore or can't get the gas to market, there's often no economically feasible outlet for the gas. In this case, companies want to get rid of the gas, so they often burn -- or flare -- it.

Thankfully, there is some value to the gas, so there can be some savings associated with stopping flaring. I think setting the expectation that the gas will be managed properly is the role of the regulatory environment. There are some efforts underway to try to tackle this -- the World Bank has a big effort called the Global Gas Flaring Reduction Partnership, where companies have

banded together to try to set flaring targets, so hopefully this will start to decline.

This work represents the first study breaking down oil-industry greenhouse gas emissions at the country level. What data did you look at to do this work?

This is the culmination of a larger project we've been working on for eight or so years. We used three different data sources. For some countries you can get data from governmental sources or regulatory agencies. Environmental agencies and natural resource agencies will also report information we can use. Otherwise, we go to petroleum engineering literature to get information about oil fields. Then we were able to collaborate with Aramco, an international oil company, to access a commercial data set. That allowed us to fill in gaps for a lot of smaller projects that are harder to get information on or the data gathering was just too intensive. With that, our paper covers about 98 percent of global oil supply. Necessarily, it's the first time we've been able to do this at this very resolved oil field-by-oil field level.

In mapping the world's oil supply, how did you estimate emissions from flaring on a country-by-country basis?

One of the challenges with flaring is that most countries don't report it. In many countries, we ended up using country-level average satellite data collected by the National Oceanic and Atmospheric Administration. Scientists there have developed ways to estimate the amount of gas flared using the brightness of the flare as seen from space. It's essentially an eye in the sky. For instance, Russia won't say how much they are flaring, but we can see it from the satellite.

Where have you seen flaring regulations work?

Offshore Canada has had a good success over the last 15 years. Basically, the rules there say that you're not allowed to flare above a certain amount. If flaring goes above a permitted level, Canada requires their offshore fields to shut down until they handle the gas. This can be done by reinjecting it back into the ground, converting it to liquefied natural gas or installing gas pipelines to get the gas to customers. Canadian flaring has dropped significantly, and these regulations prove that you can manage flaring and

require that people do something productive with the gas or put it back underground. Really, the challenge with flaring is there needs to be a policy or a regulatory apparatus to say, "Burning gas with no purpose isn't allowed; put it back in the ground or find something useful to do with it."

In the absence of federal action, how can we prioritize flaring reductions here in the U.S.?

If you don't see action at the U.S. federal level, you can work with leadership from state agencies. A good example of this was the state of North Dakota. North Dakota contains the Bakken Formation, which is one of the main regions for producing oil from hydraulically fractured wells. Five years ago, 30 percent of the gas being produced was being flared, and essentially the state government said this is not acceptable. Thirty percent was way too high and the gas had value -- it could be sold to cities like Chicago, Calgary or Denver. The government set a target for 10 percent, with the threat of potential production restrictions if producers didn't meet the target. So what happened? Producers in the region actually met the 10 percent target ahead of time. So I think things can keep moving forward. Obviously, it'd be better if we had some sort of federal action on this, but states can do a lot.

Who can drive the change needed across the globe?

Globally, I think international oil companies can really take the lead. A lot of the projects with flaring are in countries where environmental issues are poorly regulated. But many of these projects are developed by the local national oil company in cooperation with international partners. It's hard to wait on developing countries without large budgets or sophisticated regulatory capacity to put flaring rules into place. Instead of waiting for that to happen, we might expect the international oil companies work to solve the problems themselves by applying best practices from places were regulations have already solved the problem. For example, companies in Nigeria have increased gas reinjection and developed liquefied natural gas projects to get the gas to markets.

In the coming decades, we are going to be using a lot of oil and gas. It's inevitable. Taking best practices and applying them in places that are not as well regulated right now -- but hopefully will be -- can allow improvements

in one region to benefit another region.

Hopefully, we'll transition as quickly as possible to renewables, but while we use oil and gas in the meantime, let's do it responsibly.

The work was funded by the Natural Sciences and Engineering Research Council of Canada, Aramco Services Co., Ford Motor Co., the Carnegie Endowment for International Peace, the Hewlett Foundation, the ClimateWorks Foundation and the Alfred P. Sloan Foundation.

Inhibiting nuclear factor kappa B improves heart function in a mouse model of Duchenne muscular dystrophy -- ScienceDaily

Duchenne muscular dystrophy (DMD) is a devastating genetic disease that impairs cardiac and skeletal muscle development. People with DMD gradually lose ambulation in childhood, acquire respiratory and heart failure in young adulthood and succumb to the disease by their mid-thirties. Until recently, there has been no effective treatment for the characteristic muscle-wasting progression of this disease. Provisional FDA approval of the first DMD therapy (eteplirsen) and improved disease management strategies have extended the life span of DMD patients and expanded the field of DMD research into later-stage outcomes such as cardiomyopathy (heart failure).

Overall, little is known about the mechanisms of DMD cardiomyopathy, particularly how individual signaling pathways contribute to its development. Breakthrough research published August 24, 2018 in *Nature Communications* by a large, interdisciplinary team of Medical University of South Carolina (MUSC) and Ohio State University investigators has uncovered an unexpected mechanism that underlies cardiomyopathy in DMD. The team was led by Denis Guttridge, Ph.D., professor in MUSC's Department of Pediatrics, director of the Darby Children's Research Institute, and associate director of Translational Sciences for the Hollings Cancer Center.

"Understanding cardiomyopathy is a significant achievement," explains Guttridge. "About 95 percent of patients with dystrophin gene mutations (like the one that causes DMD) develop heart failure and up to 25 percent of these patients die from it. As we've gotten better at managing patients on ventilators and with other types of care, they're living longer but extending life is also thought to put more stress on their hearts. So, heart failure needs to be considered in the overall management of this disease."

The team had previously focused on the NF-κB transcription factor in skeletal muscle and, with others, showed that it regulates both physiological (differentiation, growth, and metabolism) and pathophysiological (cachexia, atrophy, and dystrophy) aspects of skeletal muscle biology. Their finding that inhibiting NF-κB improved functioning in dystrophic limb and diaphragm muscles and reduced inflammatory damage laid the foundation for investigations into NF-κB as a potential therapeutic target in DMD.

"We'd been using skeletal muscle as a platform to understand NF-κB," explains Guttridge. "We know it drives inflammation and DMD has an inflammatory component, so then we started looking at what it does in DMD. There's also some evidence that NF-κB plays a role in heart failure, but results differ widely based on the type of heart disease-which suggests that it may act differently in various cardiac conditions. So, we began wondering how it might contribute to cardiomyopathy in DMD."

Using a mouse model of DMD (mdx), the team first established that NF-κB does, indeed, contribute to cardiac dysfunction in this disease. Specifically, their first set of experiments showed that cardiomyocyte NF-κB impairs cardiac response to beta-adrenergic stress. This is the first evidence to establish that cardiomyocyte-derived NF-κB signaling is instrumental in promoting dystrophic cardiac dysfunction.

Their next experiments found that cardiomyocyte NF-κB, though not required for the development of cardiac fibrosis or myocyte injury in mdx mice, still contributes to cardiac dysfunction. The question then became "How?" Published evidence indicated that genes related to calcium were enriched in the absence of NF-κB. The team followed this proposed link between NF-κB and calcium using microarray analyses to compare the hearts of NF-κB knock-out mice ($mdx^{HRT\Delta IKK\beta}$) with littermates that had intact NF-κB ($mdx^{IKK\beta f/f}$).

They found that cardiomyocyte NF-κB ablation normalized calcium handling and significantly increased calcium gene expression.

Taking a broader look at overall gene expression patterns in dystrophic hearts lacking NF-κB, they found that it played a previously unreported functional role as a global repressor in mdx hearts.

"This mechanism was unexpected," says Guttridge. "We thought that when the pathway was ablated, the global gene expression pattern would be down-regulated because NF-κB is supposed to be an activator. Surprisingly, we saw the opposite-about 75 percent of genes were upregulated. That told us that NF-κB was acting as a transcriptional repressor."

The team's next series of experiments uncovered that, although NF-κB was activated in dystrophic hearts, it was not playing its canonical role as a direct transcriptional activator but rather was modulating chromatin conformation to deplete H3K27ac. A reduction of this chromatin mark indicates that there is a repression on gene expression. This depletion, in turn, repressed the Slc8a1 gene, which codes for the NCX1 protein. And, here's the rub -- NCX1 plays a crucial role in maintaining calcium homeostasis in multiple cell types, including muscle.

"When we dug deeper to find out how and exactly what genes it was repressing, we saw that the ones that were going up were mostly calcium-handling genes like Slc8a1. Without proper mobilization of calcium, the heart doesn't contract normally," says Guttridge, "The reason NF-κB was acting as a repressor of calcium genes now made a lot of sense."

While it is understood that the pathology of dystrophic hearts is caused by disruption of calcium homeostasis, the exact mechanisms driving this disruption have not previously been explored. Furthermore, these findings have important implications for the treatment of heart failure in multiple conditions including diabetes and after ischemia-reperfusion injuries. Perhaps most important, these findings highlight that targeting NF-κB could benefit both skeletal and cardiac muscle.

"I'm very excited about these findings!" says Guttridge. "As a scientist, you follow your hunches and try to vigorously test your hypotheses -- it's so satisfying to have found a pathway that we believe contributes to the pathology of DMD, not just in skeletal muscle but also in the heart. This gives us hope that a drug can be developed that has the possibility of improving patients' lives."

Scientists identify protein that may have existed when life began: The primordial peptide may have appeared 4 billion years ago -- ScienceDaily

How did life arise on Earth? Rutgers researchers have found among the first and perhaps only hard evidence that simple protein catalysts -- essential for cells, the building blocks of life, to function -- may have existed when life began.

Their study of a primordial peptide, or short protein, is published in the Journ*al of the American Chemical Society*.

In the late 1980s and early 1990s, the chemist Günter Wächtershäuser postulated that life began on iron- and sulfur-containing rocks in the ocean. Wächtershäuser and others predicted that short peptides would have bound metals and served as catalysts of life-producing chemistry, according to study co-author Vikas Nanda, an associate professor at Rutgers' Robert Wood Johnson Medical School.

Human DNA consists of genes that code for proteins that are a few hundred to a few thousand amino acids long. These complex proteins -- needed to make all living-things function properly -- are the result of billions of years of evolution. When life began, proteins were likely much simpler, perhaps just 10 to 20 amino acids long. With computer modeling, Rutgers scientists have been exploring what early peptides may have looked like and their possible chemical functions, according to Nanda.

The scientists used computers to model a short, 12-amino acid protein and tested it in the laboratory. This peptide has several impressive and important features. It contains only two types of amino acids (rather than the estimated 20 amino acids that synthesize millions of different proteins needed for

specific body functions), it is very short and it could have emerged spontaneously on the early Earth in the right conditions. The metal cluster at the core of this peptide resembles the structure and chemistry of iron-sulfur minerals that were abundant in early Earth oceans. The peptide can also charge and discharge electrons repeatedly without falling apart, according to Nanda, a resident faculty member at the Center for Advanced Technology and Medicine.

"Modern proteins called ferredoxins do this, shuttling electrons around the cell to promote metabolism," said senior author Professor Paul G. Falkowski, who leads Rutgers' Environmental Biophysics and Molecular Ecology Laboratory. "A primordial peptide like the one we studied may have served a similar function in the origins of life."

Falkowski is the principal investigator for a NASA-funded ENIGMA project led by Rutgers scientists that aims to understand how protein catalysts evolved at the start of life. Nanda leads one team that will characterize the full potential of the primordial peptide and continue to develop other molecules that may have played key roles in the origins of life.

With computers, Rutgers scientists have smashed and dissected nearly 10,000 proteins and pinpointed four "Legos of life" -- core chemical structures that can be stacked to form the innumerable proteins inside all organisms. The small primordial peptide may be a precursor to the longer Legos of life, and scientists can now run experiments on how such peptides may have functioned in early-life chemistry.

Study co-lead authors are John Dongun Kim, postdoctoral researcher, and graduate student Douglas H. Pike. Other authors include Alexei M. Tyryshkin and G.V.T. Swapna, staff scientists; Hagai Raanan, postdoctoral researcher; and Gaetano T. Montelione, Jerome and Lorraine Aresty Chair and distinguished professor in the Department of Molecular Biology and Biochemistry. He is also a resident faculty member at the Center for Advanced Technology and Medicine.

Story Source:

Materials provided by **Rutgers University**. *Note: Content may be edited for*

style and length.

Faster than we thought: Sulfurization of organic material: New research is changing our understanding of the carbon cycle -- ScienceDaily

About 94 million years ago, something happened that led to an unusually high amount of organic material being preserved in oceans around the world.

The burial of this organic carbon -- over about a half million years -- pulled an enormous amount of CO2 out of the atmosphere and had a major impact on Earth's climate.

The basic assumption has been that some combination of super-giant algae blooms and low levels of oxygen in the ocean allowed the organic carbon from these blooms to be preserved in sediments.

New research from the department of Earth and Planetary Sciences at Washington University in St. Louis shows that there is another process by which this carbon was preserved. Organic matter sulfurization -- which previously had been thought to act over timescales of tens of thousands of years -- can actually occur much faster, according to research published earlier this week in the journal *Nature Communications*.

This change in timescales may have sizable implications for how scientists understand the past and future of Earth's climate.

Organic matter sulfurization reactions can occur on the timescale of just hours to days, according to the paper, "Organic carbon burial during OAE2 driven by changes in the locus of organic matter sulfurization."

"We can even induce them in 24 hours in the lab," said Morgan Reed Raven, assistant professor in earth science at the University of California, Santa Barbara.

Raven headed this research as the Agouron Geobiology Fellow at Washington University.

The finding focused on a layer of sediment in the south of France from that time period, about 94 million years ago, known as the Ocean Anoxic Event 2 (OAE2). The site is more typical of other places and times on the planet then sites where many previous studies focused. For this reason, Raven said, "There are all sorts of places on Earth today where rapid sulfurization is on the table as a major mechanism for impacting how much carbon is preserved."

The potential widespread nature of sulfurization as a manner of carbon preservation means that our understanding of the history of oxygen in the ocean may need to be reevaluated.

The amount of sedimentary carbon has acted as a kind of proxy for oxygen levels in the ocean. The more carbon in the sediment, the thinking went, the less oxygen was in the ocean. (If there's no oxygen, there are no microbes or animals to eat organic material, so when that material dies, it accumulates in the ocean floor).

"That is probably still correct," said David Fike, International Center for Energy, Environment & Sustainability (InCEES) Professor in the Department of Earth and Planetary Sciences in Arts & Sciences, associate director of InCEES and director of the Environmental Studies program.

"But Morgan showed this other process," he said. "Even with oxygen in the system, if there is sulfur in the organic matter, nothing can easily eat it," and the matter will still be preserved in the sediment.

"People have known about sulfurization, but they thought it was slow and not that important environmentally," Fike said. "What Morgan has been able to show is that it is a much more efficient and powerful way to lock up matter, to trap the organics."

Going forward, he said, this work highlights an additional process that will be important to include in climate modelling.

"We hope that through this paper and others," Fike said, "modelers will see this as an important process to incorporate into their systems."

Raven has done research in a variety of environments, the results of which will be published in forthcoming papers. "The hypotheses that came out of this paper do seem to be holding up," she said. "And for understanding the formation of many extremely organic carbon-rich sediments, these rapid sulfur reactions are where the story is at."

Biomechanics of chewing depend more on animal size, not diet: Researchers subjected 3D-printed structures of the jaw joint of bears, wolves and other carnivorans to pressures of up to hundreds of pounds -- ScienceDaily

Chewing: We don't think about it, we just do it. But biologists don't know a lot about how chewing behavior leaves telltale signs on the underlying bones. To find out, researchers at the Jacobs School of Medicine and Biomedical Sciences at the University at Buffalo have been studying the jaw joints of carnivorans, the large mammalian order that includes dogs, cats and bears.

Last week, the scientists described results that they didn't expect to find. In the paper, published online on Aug. 24 in PLOS ONE, they reported that the jaw joint bone, the center around which chewing activity revolves (literally), appears to have evolved based more on an animal's size than what it eats.

While focused on carnivorans, the research may also provide some clues to how jaw joints function in general, including in humans and could improve the understanding of temporomandibular disorders (TMJ), which cause pain in the jaw joint and in the muscles that control the jaw.

"Even though it is clear that the carnivoran jaw joint is important for feeding, no one knew if jaw joint bone structure across species was related to the mechanical demands of feeding," explained M. Aleksander Wysocki, first author and a doctoral student in the new computational cell biology, anatomy and pathology graduate program in the Department of Pathology and Anatomical Sciences in the Jacobs School.

Wysocki and co-author Jack Tseng, PhD, assistant professor in the

Department of Pathology and Anatomical Sciences in the Jacobs School, took a multifaceted approach. They examined 40 different carnivoran species from bobcats to wolves, looking at the jaw joint bone called the mandibular condyle.

The jaw's pivot point

"The mandibular condyle is the pivot point of the jaw, it functions similarly to the way the bolt of a door hinge does," Wysocki said. "Studies have shown that this joint is loaded with force during chewing."

He noted that the team was especially interested in the intricate, spongey bone structures inside the jaw joint, also known as trabecular bone. "We thought that this part of the skull would be the best candidate for determining relationships between food type and anatomy."

For example, because hyenas crush bone while consuming their prey, it could be assumed that their jaw joints would need to be capable of exerting significant force. "On the other hand, an animal that eats plants wouldn't be expected to require that kind of jaw joint structure," he said. "But we found that diet has a weaker relationship with skull anatomy than we thought. Mostly it's the animals' size that determines jaw joint structure and mechanical properties."

The researchers took computed tomography (CT) scan data of skulls from 40 species at the American Museum of Natural History, then built 3D models of them, from which they extracted the internal bone structure. Using a 3D printer, the scientists then printed 3D cores, based on virtual "core samples" taken from the mandibular condyle of each jaw joint, which they then scaled and tested for strength.

"Using a compression gauge, we measured how rigid these jaw joint structures were and how much force they could withstand," Wysocki said.

No significant correlation

The testing revealed no significant correlations between the shape or mechanical performance of the jaw joint bone and the diets of particular

carnivorans.

"The mandibular condyle absorbs compressive force during chewing so we hypothesized that this was a part of the skull that was likely to be influenced by what the animal eats," Wysocki said. "It turns out that body size is the key factor determining the complexity of jaw joint bone structure and strength."

He noted that some previous research has revealed that despite the wide variety of diets consumed by different carnivorans, the overall skull shape is considerably influenced by non-feeding variables.

"Still, given how critical the temporomandibular joint is in capturing prey and eating it, these results are very striking," he said. "For over a century, it has been assumed that skull shape is closely related to what an animal eats. And now we have found that jaw joint bone structure is related to carnivoran body size, not what the animal is eating."

Wysocki said that the reasons for this apparent disconnect may be that larger carnivorans don't need such powerful jaws because they are proportionately larger than their prey, or possibly because they share the work involved by hunting in groups. He also said that other factors such as developmental constraints of bone structure could play a role in producing the trends observed in the study.

"Our research shows that factors other than diet need to be considered when attempting to understand jaw joint function," Wysocki concluded. "It turns out that the functional anatomy of the jaw joint is much more complex than we thought."

For the record, the findings revealed that the species that demonstrated the greatest maximum compressive strength during chewing force simulations, was the wolverine (*Gulo gulo*), followed by the cheetah (*Acinonyx jubatus*), the malagasy civet (*Fossa fossana*), the honey badger (*Mellivora capensis*) and the kinkajou (*Potos flavus*).

Injection wells can induce earthquakes miles away from the well: Study finds injecting fluid into sedimentary rock can produce bigger, more distant earthquakes than injecting into the underlying basement rock -- ScienceDaily

A study of earthquakes induced by injecting fluids deep underground has revealed surprising patterns, suggesting that current recommendations for hydraulic fracturing, wastewater disposal, and geothermal wells may need to be revised.

Researchers at UC Santa Cruz compiled and analyzed data from around the world for earthquakes clearly associated with injection wells. They found that a single injection well can cause earthquakes at distances more than 6 miles (10 kilometers) from the well. They also found that, in general, injecting fluids into sedimentary rock can cause larger, more distant earthquakes than injecting into the underlying basement rock.

"This is problematic, since the current advice is to preferentially inject into the sedimentary sequence as a theoretically safer alternative to the basement rock," said Emily Brodsky, professor of Earth and planetary sciences at UC Santa Cruz.

Postdoctoral researcher Thomas Goebel said the key issue is the spatial footprint of induced seismicity around the injection well. "It's not that the basement rock is safe, because there is still the possibility of encountering a fault in the basement rock that can cause a large earthquake, but the probability is reduced because the spatial footprint is smaller," he said.

In a paper published August 31 in *Science*, Goebel and Brodsky described

two distinct patterns of induced seismicity, which they associated with different physical mechanisms acting in basement rock and sedimentary rock. In the first pattern, associated with injection into basement rock, earthquakes tend to occur in a compact cluster around the well, with a steep decline in earthquakes farther from the well. In the other pattern, associated with sedimentary rock, induced earthquakes decline gradually with distance from the well and occur at much greater distances.

The physical mechanism by which injection wells induce earthquakes was thought to be a direct result of increased fluid pressure in the pores of the rock, causing faults to slip more easily. This mechanism can account for the spatial pattern of seismicity seen with injection into basement rock, Goebel said. But the pattern seen with injection into sedimentary rock suggests a different mechanism resulting from efficient "poroelastic coupling," which controls the ability of the rock to transmit fluid stresses into the solid rock matrix.

"When you inject water into the ground, it pushes on the surrounding rock and creates elastic stress in the rock, which can put pressure on faults at a distance without putting water into those faults. So if poroelasticity is dominant, you end up with a larger footprint because it's loading neighboring faults beyond the area of increased pore pressure," Brodsky said.

According to Goebel, the crystalline basement rock is stiffer and has lower porosity than sedimentary rock. "Therefore, the increase in pore pressure is limited to isolated pockets around the well, and the coupling of that with the overall stress field is low," he said.

Goebel said their findings help explain the extent of induced seismicity in regions such as Oklahoma where there are many injection sites in oil and gas fields. Oklahoma has seen a dramatic surge in earthquakes since 2010, to the extent that there are now more earthquakes each year in Oklahoma than in California. Goebel and Brodsky did not include sites in Oklahoma in their study, however, because there are so many injection wells they couldn't isolate the effects of individual wells.

"In Oklahoma, they are injecting into the high-porosity sedimentary unit above the basement, but these elastic stresses can be transmitted over a large

distance, so you could activate a large basement fault at a distance of 10 kilometers," Goebel said. "That may be what we're seeing in places like Oklahoma."

Story Source:

Materials provided by **University of California - Santa Cruz**. Original written by Tim Stephens. *Note: Content may be edited for style and length.*

DNA accessibility, gene expression jointly profiled in thousands of cells: New assay advances research on how various cells types interpret their genetic code -- ScienceDaily

Scientists have now developed an assay that concurrently profiles both the epigenome and transcriptome of each of thousands of single cells.

The epigenome and transcriptome are part of the molecular biology that converts a genetic blueprint into tools and materials for living cells.

The genomes of different types of cells may be identical, while their epigenomes and transcriptomes are not. The epigenome consists of a set of marks that shape what each cell's genome will do, while the transcriptome is the set of copies of the instructions themselves. These encode the production of proteins. The flow of information from the inherited plan to the making of proteins is critical for forming and maintaining life.

Cells can access only certain portions of their chromatin-packaged, double-stranded genome during RNA transcription. Because this access varies among different cell types, chromatin accessibility is what helps determine the shape, function and variety of the diverse cells in a multi-cellular, living organism.

The researchers call their assay sci-CAR. Sci stands for single-cell combinatorial indexing, a means of studying large numbers of single cells at once. In a research report Aug. 30 in *Science*, the scientists describe how the new assay merges two other genomic assays into one protocol.

These assays, among their other features, incorporate unique barcodes for the nucleic acid contents of cells or of the cell nucleus, which contains the main

control center for living cells. The scientists' method for labeling and sorting cells lets them link the messenger RNA and chromatin accessibility profiles of individual cells.

Most assays of what goes on genetically inside single cells, the scientists noted, can survey only one aspect of cellular biology. The ability to investigate several classes of molecules concurrently could uncover, for example, how certain genetic mechanisms are related and regulated.

It could also improve the usefulness of cell atlases of complex organisms, like those of the worm or mouse. Eventually, it could be helpful in compiling a human cell atlas.

The new method was developed by scientists at the Brotman Baty Institute for Precision Medicine in Seattle, University of Washington School of Medicine Department of Genome Sciences, Oregon Health Sciences University, Illumina, Inc., in California, Allen Discovery Center for Cell Lineage Tracing, and Howard Hughes Medical Institute.

The first author of the study is Junyue Cao, a graduate student in the Molecular and Cellular Biology program and in genome sciences at the University of Washington School of Medicine. The study was led by Jay Shendure and Cole Trapnell. Both are faculty in the Department of Genome Sciences at the UW School of Medicine and investigators at the Brotman Baty Institute, where Shendure is the director.

The researchers first tried their co-assay on more than 4,800 cells in a lung-cancer-derived cell culture model of cortisol response. In this model, the cells are treated with the corticosteroid dexamethasone. This synthetic steroid can activate the binding of thousands of locations on the genome and change the expression of hundreds of genes.

The scientists then examined the time course of dexamethasone's effects on gene expression, as well as dynamic changes that occurred in chromatin accessibility in the same cells.

In related work, the researchers sought to study the gene-control landscape that underlies the messenger RNA collections found in the different types of

cells in the mammalian kidney.

In applying their co-assay to the nuclei from whole mouse kidneys, they recovered both transcriptome and chromatin accessibility profiles from 11,296 cells. They clustered their mouse kidney cells into 14 groups, and characterized cell-type specific epigenome landscapes and linked transcriptome features.

Based on the covariance between epigenome and transcriptome, the researchers also learned that they could draw links between distant genomic regulatory elements and their targeted genes to explain some of the differences in gene expression across various cell types.

Looking forward, there are clear advantages of a joint assay over assays that only profile either RNA transcription or DNA accessibility. One advantage of sci-CAR specifically is that this method could potentially be used to jointly assay millions of single cells at once.

Among its limitations is the sparseness of some of the chromatin accessibility data. The researchers suggested that this might be overcome in future experiments by optimizing some aspects of the current protocol.

The researchers hope to continue to combine additional co-assays so that molecular biologists could concurrently trace the flow of genetic information from DNA to RNA to specific proteins in each of the many single cells that can exist in complex living things.

Simple test detects disease-carrying mosquitoes, presence of biopesticide -- ScienceDaily

A new diagnostic tool has been developed by researchers at The University of Texas at Austin that can easily, quickly and cheaply identify whether a mosquito belongs to the species that carries dangerous diseases such as Zika virus, dengue, chikungunya or yellow fever. It can also determine whether the bug has come into contact with a mosquito-control strategy known as *Wolbachia*.

"Many of these diseases are spreading in areas where they weren't common before," said Sanchita Bhadra, a research associate in the Department of Molecular Biosciences and first author on the paper. "Having surveillance is important in conjunction with any kind of outbreak, and this method allows a rapid test in the field."

The tool uses a smartphone camera, a small 3D-printed box and a simple chemical test to show whether a dead mosquito belongs to the *Aedes aegypti* species. *Aedes aegypti* carries Zika and other devastating viruses that afflict an estimated 100 million people worldwide each year. The species also is closely linked to the tripling of cases of mosquito-borne diseases in the United States since 2004.

The research appears in the journal *PLOS Neglected Tropical Diseases*.

The tool developed by scientists and students at UT Austin also detects the presence of a biopesticide called *Wolbachia*, a type of bacteria that keeps mosquitoes from spreading diseases. In countries around the world and in 20 U.S. states where the *Aedes aegypti* mosquito is found, scientists working in public health agencies have started to infect mosquitoes with *Wolbachia* by introducing the bacteria into a local mosquito population to help curb transmission of viruses.

Because mosquitoes show no outward signs of having the bacteria -- and because existing diagnostic tests are hard to read, expensive and logistically cumbersome -- the new tool represents a significant step forward for those hoping to monitor the effectiveness of *Wolbachia*.

"This test can happen without involving a lot of staff and equipment to make sure *Wolbachia* is effective and spreading as anticipated," Bhadra said.

Public health groups trap and kill mosquitoes routinely in conjunction with monitoring efforts, but existing technology requires a complex process to extract nucleic acid from inside mosquitoes, often after they have been dead for days and have started to decay, leading to greater expense and the possibility of more errors in lab tests than the new technology.

The new diagnostic tool uses a smartphone's camera and a simple test that can be done anywhere. It tests mosquitoes' nucleic acid without requiring a complicated process to remove it. Officially known as a loop-mediated isothermal amplification and oligonucleotide strand displacement, or LAMP OSD, the probe delivers a simple yes-or-no readout on a cellphone, with accuracy of greater than 97 percent.

In addition to the tests to detect mosquito species and *Wolbachia*, the team also is exploring use of the technology to easily identify whether trapped mosquitoes are carrying Zika, dengue and other pathogens.

Story Source:

Materials provided by **University of Texas at Austin**. *Note: Content may be edited for style and length.*

Society News

Top stories featured on ScienceDaily's Science & Society, Business & Industry, and Education & Learning sections.

- **No evidence that moral reminders reduce cheating behavior, replication effort concludes** [周三, 05 9月 04:46]
  Scientists report they were unable to reproduce the results of a well-known study showing that people are less likely to cheat on a task after making a list of the Ten Commandments.
- **Why we stick to false beliefs: Feedback trumps hard evidence** [周三, 05 9月 03:03]
  Ever wonder why flat earthers, birthers, climate change and Holocaust deniers stick to their beliefs in the face of overwhelming evidence to the contrary? New findings suggest that feedback, rather than hard evidence, boosts people's sense of certainty when learning new things or trying to tell right from wrong.
- **Patients want more information about their medicines, study finds** [周三, 05 9月 02:05]
  Many patients want more information on the medicines they're prescribed and greater say in the brands they use, the first major study of the burden of long-term medicine use has concluded.
- **You act most like 'you' in a time crunch, study finds** [周三, 05 9月 02:05]
  When they must act quickly, selfish people are likely to act more selfishly than usual, while pro-social people behave even more pro-socially, a new study found.
- **Induced changes to political attitude can last over time** [周二, 04 9月 22:30]
  Cognitive scientists have demonstrated that experimentally induced changes in political attitudes can last over time. Notably, participants who verbally motivated these 'false attitudes' exhibited the largest changes. This is the first time a lasting effect of the choice blindness phenomenon has been observed.
- **Troubling disadvantages, including bias, against women in business, study finds** [周二, 04 9月 21:38]
  A two-and-a-half-year research study documents bias against women seeking CEO jobs in the workforce.
- **Can social media networks reduce political polarization on climate change?** [周二, 04 9月 03:29]
  Political bias often leads to polarization on topics like climate change. But a new study has shown that

exposure to anonymous, bipartisan social networks can make a striking difference, leading both liberals and conservatives to improve their forecasting of climate-change trends.

- **Lack of social mobility more of an 'occupational hazard' than previously known** [周二, 04 9月 03:29]
  American workers' occupational status reflects that of their parents more than previously known, reaffirming more starkly that the lack of mobility in the United States is in large part due to the occupation of our parents.

- **Tracking marine migrations across geopolitical boundaries aids conservation** [周一, 03 9月 23:34]
  A new study uses tracking data for 14 species of migratory marine predators, from leatherback turtles to blue whales and white sharks, to show how their movements relate to the geopolitical boundaries of the Pacific Ocean. The results provide critical information for designing international cooperative agreements needed to manage these species.

- **Age, race or need for instant gratification -- which best predicts how much you will earn?** [周一, 03 9月 22:17]
  Traditional statistics have allowed researchers to understand which things -- like education, occupation and gender -- predict how much a person will earn. Now, in the first study of its kind, researchers have used machine learning to rank the importance of these factors, finding that a person's ability to delay immediate gratification is among the best predictors of affluence.

- **The low impact of the high-speed train on international tourism** [周五, 31 8月 23:04]
  There is undeniably a complementary relationship between air travel and the high-speed train. However, and although both means of transport favor tourism, European experience indicates that their influence is very different.

- **Sharp rise in essay cheating globally, with millions of students involved** [周五, 31 8月 23:03]
  A new study has revealed that one in seven students are using essay-mills -- representing around 31 million globally.

- **Using physics to predict crowd behavior** [周五, 31 8月 06:01]
  Electrons whizzing around each other and humans crammed together at a political rally don't seem to have much in common, but researchers are connecting the dots. They've developed a highly accurate mathematical approach to predict the behavior of crowds of living creatures, using methods originally developed to study large collections of quantum mechanically interacting electrons.

- **Countries ranked by oil production emissions** [周五, 31 8月 06:01]
  Emissions associated with oil and gas production are a significant source of greenhouse gases. A new analysis ranks countries by emission levels and identifies the major sources of emissions, a first step toward policy to regulate oil and gas production practices.

- **New survey reveals 57 percent of Americans have been surprised by a medical bill** [周五, 31 8月 02:30]
  Fifty-seven percent of American adults have been surprised by a medical bill that they thought would have been covered by insurance, according to a new study. Respondents indicated that 20 percent of their surprise bills were a result of a doctor not being part of the network.
- **Selling access to human specimens: Survey reveals public attitudes** [周五, 31 8月 00:51]
  Universities that aim to raise money for research by selling access to their biobanks to private companies should tell patients, a new survey shows. In fact, saying what the money will be used for will likely encourage patients to donate their samples.
- **Information technology jobs outpace most other jobs in productivity and growth since 2004** [周五, 31 8月 00:22]
  Jobs in information technology -- like computer software, big data, and cybersecurity -- are providing American workers with long-lasting financial stability, suggests a new study.
- **When God is your only friend: Religion and the socially disconnected** [周四, 30 8月 23:30]
  New research finds that religious people who lack friends and purpose in life turn to God to fill those voids. However, the findings do not suggest that people who are socially disconnected are more likely to become religious if they were not already.
- **Financial disclosure lacking in publication of clinical trials, study finds** [周四, 30 8月 23:29]
  A substantial proportion of pharmaceutical industry payments to authors of oncology clinical trials published in major scientific journals are not disclosed, new research shows.
- **The god of small things** [周四, 30 8月 21:53]
  New research suggests people who are religious gain happiness from believing there is a deeper meaning to everyday events.
- **Mongrel Mob gang opens up to New Zealand researchers for the good of their health** [周四, 30 8月 21:12]
  A gang known as the Mongrel Mob has opened up to New Zealand researchers, who have assessed the hepatitis prevalence, knowledge, and liver health risk factors of 52 gang members, affiliates and extended family.
- **Deadline for climate action: Act strongly before 2035 to keep warming below 2°C** [周四, 30 8月 20:48]
  If governments don't act decisively by 2035 to fight climate change, humanity could cross a point of no return after which limiting global warming below 2°C in 2100 will be unlikely, according to a new study. The research also shows the deadline to limit warming to 1.5°C has already passed, unless radical climate action is taken.

- **Better fisheries management could help offset climate change's negative effects, research suggests** [周四, 30 8月 03:39]
  New research shows a more prosperous global future is possible if both climate change and sustainable fisheries management are addressed now.
- **Protect key habitats, not just wilderness, to preserve species** [周四, 30 8月 02:38]
  Some scientists have suggested we need to protect half of Earth's surface to preserve most of its species. A new study, however, cautions that it's the quality, not merely the quantity, of land we protect that matters. To preserve biodiversity more fully, especially species with small ranges, governments should expand their conservation focus and prioritize key habitats outside wildernesses and current protected areas. The study identifies where some of the most urgent conservation gaps occur.
- **Teen dating violence is down, but boys still report more violence than girls, British Columbia study finds** [周四, 30 8月 01:31]
  When it comes to teen dating violence, boys are more likely to report being the victim of violence -- being hit, slapped, or pushed -- than girls. That's the surprising finding of new research from British Columbia, Canada.
- **China is hot spot of ground-level ozone pollution** [周三, 29 8月 23:55]
  In China, people breathe air thick with the lung-damaging pollutant ozone two to six times more often than people in the United States, Europe, Japan, or South Korea, according to a new assessment. By one metric -- total number of days with daily maximum average ozone values (8-hour average) greater than 70 ppb -- China had twice as many high ozone days as Japan and South Korea, three times more than the United States, and six times more than Europe.
- **How unsecured medical record systems and medical devices put patient lives at risk** [周三, 29 8月 23:55]
  Physicians and computer scientists have shown it is easy to modify medical test results remotely by attacking the connection between hospital laboratory devices and medical record systems.
- **Celebrity culture likely contributed to destigmatizing out-of-wedlock childbirth** [周三, 29 8月 23:55]
  In 1992, former Vice President Dan Quayle criticized the sitcom character Murphy Brown's decision to have a child out of wedlock. That ignited discussions that continue today about whether celebrities might be contributing to the demise of the nuclear family, yet 40 years of data from one reputable celebrity news source suggests that celebrities in fact have fewer out-of-wedlock childbirths compared to the rest of the U.S. population.
- **Diplomats' mystery illness linked to radiofrequency/microwave radiation, researcher says** [周三, 29 8月 23:54]

In a new article, a researcher makes the case that publicly reported symptoms and experiences of a 'mystery illness' afflicting American and Canadian diplomats in Cuba and China strongly match known effects of pulsed radiofrequency/microwave electromagnetic (RF/MW) radiation.

- **Disentangling the relationships between cultural traits and other variables** [周三, 29 8月 08:49]
  In a new article, a team of researchers analyze how to avoid misinterpreting correlations in cross-cultural studies. The researchers identify three sources of non-independence in cultural variables -- meaning, the variables are correlated but are not caused by each other -- and present methods to control for these.

No evidence that moral reminders reduce cheating behavior, replication effort concludes -- ScienceDaily

Scientists report they were unable to reproduce the results of a well-known study showing that people are less likely to cheat on a task after making a list of the Ten Commandments. Their findings are published in a Registered Replication Report (RRR) in *Advances in Methods and Practices in Psychological Science*, a journal of the Association for Psychological Science.

The RRR, led by Bruno Verschuere from the University of Amsterdam and Ewout Meijer from the University of Maastricht, presented primary analyses of data from a total of 4,674 participants collected by 19 participating labs. The RRR aimed to replicate a 2008 study in which researchers Nina Mazar, On Amir, and Dan Ariely asked participants to recall either the Ten Commandments or 10 books they had read before completing a separate problem-solving task.

Data from the original study indicated that participants who had thought about the Ten Commandments, a moral reminder, were less likely to exaggerate when self-reporting how many problems they had solved compared with those who had been prompted to think about books. The findings provided support for self-concept maintenance theory, which holds that people seek personal gain so long as they can maintain a positive self-image while doing so.

Verschuere and Meijer developed the RRR protocol in consultation with Mazar, Amir, and Ariely, who provided the materials used in the original study and feedback on the study design. The protocol was preregistered and made publicly available online -- data from participating research teams were included in RRR analyses as long as the teams followed the protocol and met the preregistered criteria for inclusion.

The RRR data showed that the moral reminder had no observable effect on cheating behavior for participants who self-reported their problem-solving performance. Among the participants who had the opportunity to cheat, those who were asked to list the Ten Commandments reported solving about 0.11 more problems than their peers who listed books they had read. This stands in contrast with findings from the original study, which showed that participants who had thought about the Ten Commandments reported solving 1.45 fewer problems than their peers.

Although the participating research teams were located in various countries (including the US), there was little variation in their findings. This suggests that the features of the individual replication attempts and participants are unlikely to explain the overall RRR finding.

However, there may be other factors that could explain the divergent results.

"There are always differences between an original study and replication research. You cannot step in the same river twice," says Verschuere. "For instance, the original study was conducted more than a decade ago at an elite university. The perceived rewards, the perceived probability of getting caught and the perceived consequences of getting caught may have been different for participants in our replication study. But we also need to consider the possibility that the effect does not exist, and that the original result was a chance finding."

In a commentary accompanying the RRR, Amir, Mazar, and Ariely write that they are "grateful for the continued investigation and inquiry into a topic that we believe is not only important but also highly relevant in today's world."

They note that there are several possible reasons why the results detailed in the RRR might diverge from those of the original study, including the smaller testing group sizes. Also, participants may simply be more aware of research on dishonesty compared with those who participated in the original study a decade ago, they said.

According to Verschuere, the results show the importance of replication research.

"The psychological theory of cheating is very appealing, but we need more replication research to establish the reliability of its empirical basis," he concludes.

Why we stick to false beliefs: Feedback trumps hard evidence: New study finds that feedback rather than hard evidence makes us more confident that we're right -- ScienceDaily

Ever wonder why flat earthers, birthers, climate change and Holocaust deniers stick to their beliefs in the face of overwhelming evidence to the contrary?

New findings from researchers at the University of California, Berkeley, suggest that feedback, rather than hard evidence, boosts people's sense of certainty when learning new things or trying to tell right from wrong.

Developmental psychologists have found that people's beliefs are more likely to be reinforced by the positive or negative reactions they receive in response to an opinion, task or interaction, than by logic, reasoning and scientific data.

Their findings, published today in the online issue of the journal *Open Mind*, shed new light on how people handle information that challenges their worldview, and how certain learning habits can limit one's intellectual horizons.

"If you think you know a lot about something, even though you don't, you're less likely to be curious enough to explore the topic further, and will fail to learn how little you know," said study lead author Louis Marti, a Ph.D. student in psychology at UC Berkeley.

This cognitive dynamic can play out in all walks of actual and virtual life, including social media and cable-news echo chambers, and may explain why some people are easily duped by charlatans.

"If you use a crazy theory to make a correct prediction a couple of times, you can get stuck in that belief and may not be as interested in gathering more information," said study senior author Celeste Kidd, an assistant professor of psychology at UC Berkeley.

Specifically, the study examined what influences people's certainty while learning. It found that study participants' confidence was based on their most recent performance rather than long-term cumulative results. The experiments were conducted at the University of Rochester.

For the study, more than 500 adults, recruited online through Amazon's Mechanical Turk crowdsourcing platform, looked at different combinations of colored shapes on their computer screens. They were asked to identify which colored shapes qualified as a "Daxxy," a make-believe object invented by the researchers for the purpose of the experiment.

With no clues about the defining characteristics of a Daxxy, study participants had to guess blindly which items constituted a Daxxy as they viewed 24 different colored shapes and received feedback on whether they had guessed right or wrong. After each guess, they reported on whether or not they were certain of their answer.

The final results showed that participants consistently based their certainty on whether they had correctly identified a Daxxy during the last four or five guesses instead of all the information they had gathered throughout.

"What we found interesting is that they could get the first 19 guesses in a row wrong, but if they got the last five right, they felt very confident," Marti said. "It's not that they weren't paying attention, they were learning what a Daxxy was, but they weren't using most of what they learned to inform their certainty."

An ideal learner's certainty would be based on the observations amassed over time as well as the feedback, Marti said.

"If your goal is to arrive at the truth, the strategy of using your most recent feedback, rather than all of the data you've accumulated, is not a great tactic," he said.

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Patients want more information about their medicines, study finds -- ScienceDaily

Many patients want more information on the medicines they're prescribed and greater say in the brands they use, the first major study of the burden of long-term medicine use has concluded.

University of Kent pharmacy expert Professor Janet Krska carried out research into what makes long-term medicine use burdensome for patients and found that those taking the highest number of medicines for the most times a day experienced the greatest impact -- with many concerned about side effects.

Surprisingly however, the study also found that older patients felt using regular medicines was less burdensome than younger patients, even though they use more medicines.

The research revealed that over a quarter of those surveyed wanted more information about their medicines and greater say in the brands of medicines they use, with a similar proportion concerned about paying for medicines. Over half were concerned about long-term adverse effects. Around 11% were not satisfied with the effectiveness of their medicines, and between 10 and 16% agreed that their medicines caused interference with some aspect of their daily life.

Thirty per cent agreed that their life revolved around medicines and only around a quarter felt they could decide whether or not to use them. There were 16% who didn't feel their doctor listened to their opinion about medicines and 11% said that their doctor didn't take concerns about side effects seriously.

Professor Krska and two other researchers at the University's Medway School of Pharmacy developed a new questionnaire -- known as the Living with Medicines Questionnaire (LMQ) -- to measure medicine burden. Eight areas

were covered: relationships with health professionals, practical difficulties, interference with daily life, lack of effectiveness, side effects, general concerns, cost and lack of autonomy.

Professor Krska said: 'The drive to implement clinical guidelines is contributing to increasing medicines use across the country, but the impact of this on patients among healthcare professionals is not always considered. Our study suggests that it's time for this to change.'

Story Source:

Materials provided by **University of Kent**. *Note: Content may be edited for style and length.*

You act most like 'you' in a time crunch, study finds: Under time pressure, selfish people act even more selfishly -- ScienceDaily

When they must act quickly, selfish people are likely to act more selfishly than usual, while pro-social people behave even more pro-socially, a new study found.

The results suggest that when people don't have much time to make a decision, they go with what they've done in similar situations, said Ian Krajbich, co-author of the study and assistant professor of psychology and economics at The Ohio State University.

"People start off with a bias of whether it is best to be selfish or pro-social. If they are rushed, they'll tend to go with that bias," Krajbich said.

But when people have more time to decide, they are more likely to go against their bias as they evaluate the options in front of them, he said.

Krajbich conducted the study with Fadong Chen of Zhejiang University in China. Their results were published Sept. 3 in the journal *Nature Communications*.

The study involved 102 college students from the United States and Germany who played 200 rounds of a game that is often used in psychology and economics experiments. In each round, played on a computer, the participants chose between two ways of splitting up a real sum of money. Both choices favored the person playing the game, but one choice shared more of the money with the unseen partner.

"The participants had to decide whether to give up some of their own money to increase the other person's payoff and reduce the inequality between

them," Krajbich said.

The decision scenarios were very different. In some cases, the participants would have to give up only, say, $1 to increase their partner's payoff by $10. In others, they might have to give up $1 to give their partner an extra $1. And in other cases, they would have to make a large sacrifice -- for example, give up $10 to give their partner an extra $3.

The key to this study is that participants didn't always have the same amount of time to decide, Krajbich said.

In some cases, participants had to decide within two seconds how they would share their money as opposed to other cases, when they were forced to wait at least 10 seconds before deciding. And in additional scenarios, they were free to choose at their own pace, which was usually more than two seconds but less than 10.

The researchers used a model of the "normal" decisions to predict how a participant's decisions would change under time pressure and time delay.

"We found that time pressure tends to magnify the predisposition that people already have, whether it is to be selfish or pro-social," Krajbich said.

"Under time pressure, when you have very little time to decide, you're going to lean more heavily than usual on your predisposition or bias of how to act."

The situation was different when participants were forced to wait 10 seconds before deciding.

"People may still approach decisions with the expectation that they will act selfishly or pro-socially, depending on their predisposition. But now they have time to consider the numbers and can think of reasons to go against their bias," he said.

"Maybe you're predisposed to be selfish, but see that you only have to give up $1 and the other person is going to get $20. That may be enough to get you to act more pro-socially."

The results may help explain why some previous studies found that time pressure makes people more selfish, while others found that it makes people more pro-social.

"It really depends on where you're starting, on how you're predisposed to decide," Krajbich said.

Story Source:

Materials provided by **Ohio State University**. Original written by Jeff Grabmeier. *Note: Content may be edited for style and length.*

Induced changes to political attitude can last over time -- ScienceDaily

Cognitive scientists at Lund University and Karolinska Institutet in Sweden have demonstrated that experimentally induced changes in political attitudes can last over time. Notably, participants' who verbally motivated these "false attitudes" exhibited the largest changes. This is the first time a lasting effect of the choice blindness phenomenon has been observed.

In the study, a total of 372 participants completed a survey on healthcare, education, and environmental policy issues. Afterwards, half of them were asked to simply verify their answers, whereas the other half was asked to also give underlying arguments for their views. However, they were unaware that some of their answers had been manipulated by the experimenters and shifted to the opposite side of the spectrum. Only about 50 % of these manipulated answers were corrected by the participants, and the rest were accepted as being their own.

"This is in line with previous results using choice blindness to influence ideological attitudes," says Petter Johansson, one of the researchers behind the study. "But a critical question of interest to us was whether this attitude shift would persist, despite us not giving any further arguments or encouragement for the new position."

To investigate this, at the end of the experiment the participants were asked to complete a second survey with new questions, which also included the questions that were previously manipulated. They then returned after one full week to complete a follow up, again including the manipulated questions.

The results showed that when participants initially accepted the manipulated responses as their own, their attitudes later on shifted significantly in the direction of the manipulation. However, responses to questions that had not been manipulated kept the same position throughout all the questionnaires.

"This is of particular interest given that it's the first time lasting attitude change from choice blindness has been shown. Importantly, it shows how false beliefs, and feedback about those beliefs, can powerfully shape the interpretation and memories about one's political opinions." Philip Pärnamets, researcher at Karolinska Institutet, points out.

"It seems that part of what it might mean to hold a political attitude is to be able to draw on memories of having stated that attitude. In a sense, me being against tax cuts might result from me remembering having expressed that attitude previously. Using our manipulation, we are able to alter the participants beliefs about themselves, and we find that this leads them to change their attitudes," he explains.

When comparing those participants that only verified their answers with those who also gave supporting arguments, the researchers found that both groups exhibited lasting opinion changes, but that the effect was much larger for the participants who provided arguments.

"When people argue for a manipulated answer, we know that regardless of what they say, it cannot possibly be the reason for their original choice. This type of confabulation has hardly been studied outside the clinical context, but perhaps it is something we constantly do in our ordinary lives," main author Thomas Strandberg says.

"We also found that people who started to argue for a manipulated answer, but then suddenly stopped to correct it, still modified their opinions somewhat. These smaller shifts need to be further investigated, but it suggests that even seemingly innocuous amounts of confabulation can impact our attitudes," he continues.

"On a more positive note, in the current political climate of increasing polarization and ideological hostility, our study shows that people truly have the potential to be flexible in their political views. All that is needed is a way, like choice blindness does, to invite people to reason openly, and unleash their own powers of argumentation," Thomas Strandberg concludes.

Footnote: The study was entirely anonymous. After the experiment, the researchers explained to the participants exactly how and why their answers

had been swapped, and they gave their consent to be included in the study.

Troubling disadvantages, including bias, against women in business, study finds -- ScienceDaily

Women CEOs in America are paid less, have shorter tenures and their companies are punished in the stock market, even when their firms are just as profitable as those run by men, according to new research from Florida State University.

In addition, women CEOs are less likely to serve as board chair of their companies, and they have a much tougher time landing the top job because there is significantly less demand for their leadership compared to men.

"This research should be eye-opening to people, and I hope they take a closer look," said Michael Holmes, FSU's Jim Moran Associate Professor of Strategic Management. "We hope this sets the record straight on past research, some of which has produced conflicting results, and now people can build on this aggregation of findings."

To set the record straight, Holmes and Assistant Professor of Management Gang Wang conducted an exhaustive study focusing on the influence of gender on CEOs' careers. The business management experts conducted a meta-analysis, examining the entire body of research completed over decades, and they pored over 158 previous studies that investigated gender, companies' hiring choices and the impact of those decisions.

One of the key findings in that body of research reveals an extreme underrepresentation of women CEOs. Only 5.4 percent of Fortune 500 companies had female CEOs in 2017, and that figure was the all-time high in the United States.

"The situation for women leaders is probably worse than you think right now," Holmes said. "Many women who become CEOs are absolute rock

stars. They have graduated from elite schools and risen through the corporate ranks faster, but they get paid less, are less likely to be a firm's board chair, have shorter tenures in the job and are more likely to lead distressed firms. We wondered, 'What's going on here?'"

That question prompted Wang and Holmes to embark on a two-and-a-half-year research project -- the results were just published in the journal *Organizational Behavior and Human Decision Processes*. The study identifies a number of factors that hinder female CEOs and CEO candidates among stock market investors, corporate boards, managers, and more generally, across American culture.

Wang and Holmes grouped those factors into two basic marketplace forces: demand-side and supply-side influences that combined to stifle women's ability to get CEO jobs.

Demand-side factors reduce demand for female CEOs by limiting the willingness of companies to hire women for the job. One example of that attitude is known as "in-group favoritism," a phenomenon that causes people to view others who are similar to them as more competent. In the corporate world, where men dominate leadership jobs and company boards, that attitude means leaders tend to hire people like themselves.

The FSU research also notes the hiring process for CEOs can be influenced by gender-role stereotypes. In American culture, as well as many countries worldwide, the perceived traits of a good leader, such as aggressiveness and risk-taking, are generally seen as masculine qualities.

"Because of that bias, men have advantages obtaining and succeeding in leadership positions, while women leaders are more likely to be disliked and viewed as socially inept, due to the perceived role incongruity," the researchers wrote in the paper.

The other marketplace force influencing corporate hiring decisions, according to Wang and Holmes, is a supply-side issue. They report more women choose to leave the workforce for a variety of reasons, including family changes, lack of career advancement or perhaps outright discrimination.

In addition, the study points to a larger sociological influence on hiring CEOs. Men are socialized from childhood to display traits associated with leadership -- being forceful, aggressive, even pugnacious -- and those characteristics are generally less common among women, Holmes said, perhaps because women are raised differently.

"Females are more likely socialized to care for the home or be nurturing," he said. "Men start to develop characteristics that might help them become a CEO early in childhood, whereas fewer women do. That reduces the supply of female candidates for CEO jobs."

Wang and Holmes also documented a clear bias in the stock market against women CEOs. When they used accounting metrics to compare companies with similar financial results, for example, profits, firms run by women CEOs experienced worse stock performance than those led by men.

Wang and Holmes wrote that investors and stock market analysts, most of whom are men, likely had less direct experience with women CEOs, were influenced by in-group favoritism and gender-role stereotypes, and saw more women opting out of careers. As a result, the researchers concluded those factors prompted many investors to treat the stocks of companies led by women more harshly.

"Women have come a long way in the workforce in terms of their overall numbers and acceptance, but when it comes to stock market investors evaluating a CEO and a company that they don't know, I think investors may subconsciously discount that firm because the leader is female versus male," Holmes said. "It seems when investors take an overall look at firms, biases creep in, and people may not even be aware of them."

The research team hopes future studies focus on ways to reduce biases resulting from demand-side and supply-side forces. They believe too many women either have been pushed out of careers or opted out because they faced an uneven playing field.

Their research provides practical ideas for young women who hope to become a CEO someday, such as pursuing early and fast promotions because, as their research shows, women who do break through to become CEOs are

often younger with fewer years of experience than men.

"These women have earned their place at the top," Holmes said. "But the data shows things are different for women -- the workforce does not offer a level playing field.

"I hope when people read the research, they have some 'aha' moments with the findings, as well as the explanations. By showing these firms perform the same as companies led by male CEOs, let's get beyond the idea that women can't be good leaders. Clearly, they are good leaders. They often just aren't rewarded equally."

Rich Devine and John Bishoff, former FSU doctoral students, contributed to this research.

Can social media networks reduce political polarization on climate change? -- ScienceDaily

Social media networks, which often foster partisan antagonism, may also offer a solution to reducing political polarization, according to new findings published in the *Proceedings of the National Academy of Sciences* from a team led by University of Pennsylvania sociologist Damon Centola.

The Penn researchers asked 2,400 Republicans and Democrats to interpret recent climate-change data on Arctic sea-ice levels. Initially, nearly 40 percent of Republicans incorrectly interpreted the data, saying that Arctic sea-ice levels were increasing; 26 percent of Democrats made the same mistake. However, after participants interacted in anonymous social media networks -- sharing opinions about the data and its meaning for future levels of Arctic sea ice -- 88 percent of Republicans and 86 percent of Democrats correctly analyzed it, agreeing that sea-ice levels were dropping.

Republicans and Democrats who were not permitted to interact with each other in social media networks but instead had several additional minutes to reflect on the climate data before updating their responses remained highly polarized and offered significantly less accurate forecasts.

"New scientific information does not change people's minds. They can always interpret it to match their beliefs," says Centola, director of Penn's Network Dynamics Group and author of the new book "How Behavior Spreads." "But, if you allow people to interact with each other in egalitarian social networks, in which no individual is more powerful than another, we find remarkably strong effects of bipartisan social learning on eliminating polarization."

To test this notion for politically charged topics like climate change, Centola, along with Penn doctoral student Douglas Guilbeault and recent Penn Ph.D.

graduate Joshua Becker, constructed an experimental social media platform, which they used to test how different kinds of social media environments would affect political polarization and group accuracy.

Their study was motivated by NASA's 2013 release of new data detailing historical trends in monthly levels of Arctic sea ice. "NASA found, to its dismay, that a lot of people were misinterpreting the graph to say that there would actually be more Arctic sea ice in the future rather than less," Guilbeault explains. "Conservatives in particular were susceptible to this misinterpretation."

The researchers wondered how social media networks might alter this outcome, so they randomly assigned participants to one of three experimental groups: a political-identity setup, which revealed the political affiliation of each person's social media contacts; a political-symbols setup, in which people interacted anonymously through social networks but with party symbols of the donkey and the elephant displayed at the bottom of their screens; and a non-political setup, in which people interacted anonymously. Twenty Republicans and 20 Democrats made up each social network.

Once randomized, every individual then viewed the NASA graph and forecasted Arctic sea-ice levels for the year 2025. They first answered independently, and then viewed peers' answers before revising their guesses twice more. The study outcomes surprised the researchers in several respects.

"We all expected polarization when Republicans and Democrats were isolated," says Centola, who is also an associate professor in Penn's Annenberg School for Communication and School of Engineering and Applied Sciences, "but we were amazed to see how dramatically bipartisan networks could improve participants' judgments." In the non-political setup, for example, polarization disappeared entirely, with more than 85 percent of participants agreeing on a future decrease in Arctic sea ice.

"But," Centola adds, "the biggest surprise -- and perhaps our biggest lesson -- came from how fragile it all was. The improvements vanished completely with the mere suggestion of political party. All we did was put a picture of an elephant and a donkey at the bottom of a screen, and all the social learning effects disappeared. Participants' inaccurate beliefs and high levels of

polarization remained."

That last finding reveals that even inconspicuous elements of a social media environment or of a media broadcast can hinder bipartisan communications. "Simple ways of framing a political conversation, like incorporating political iconography, can significantly increase the likelihood of polarization," Guilbeault says.

Instead, Centola says, put people into situations that remove the political backdrop. "Most of us are biased in one way or another. It's often unavoidable. But, if you eliminate the symbols that drive people into their political camps and let them talk to each other, people have a natural instinct to learn from one another. And that can go a long way toward lessening partisan conflict."

Funding for the research came, in part, from the Social Sciences and Humanities Research Council of Canada, a Robert Wood Johnson Foundation Pioneer Grant, and the National Institutes of Health's Tobacco Centers for Regulatory Control.

Lack of social mobility more of an 'occupational hazard' than previously known -- ScienceDaily

American workers' occupational status reflects that of their parents more than previously known, reaffirming more starkly that the lack of mobility in the United States is in large part due to the occupation of our parents, finds a new study by New York University's Michael Hout.

"A lot of Americans think the U.S. has more social mobility than other western industrialized countries," explains Hout, a sociology professor. "This makes it abundantly clear that we have less."

Previous research had used occupation metrics that relied on averages to gauge social status across generations. This dynamic, also called "intergenerational persistence," is the degree to which one generation's success depends on their parents' resources.

While these studies showed a strong association between parental occupation and intergenerational persistence, they understated the significance of parents' jobs on the status of their children.

The new findings, which appear in the journal *Proceedings of the National Academy of Sciences*, reveal a more powerful link as they rely on data that use medians, or middle points, as opposed to average socioeconomic status, in gauging occupations.

The findings, which take into account pay and education of those in a given occupation, are based on General Social Survey (GSS) data from 1994 through 2016.

To measure occupation, GSS interviewers asked respondents for detailed descriptions of their current occupation, their father's occupation when they

were growing up, and (since 1994) their mother's occupation while they were growing up. Their replies were coded to 539 occupational categories, following protocols established by the U.S. Census Bureau, and then given a socioeconomic score ranging from 9 (shoe shiner) to 53 (flight attendant) to 93 (surgeon).

"The underlying idea is that some occupations are desirable and others less so," explains Hout.

Notably, the study shows that the sons and daughters of high-status parents have more advantages in the labor force than earlier estimates suggested.

For example, half the sons and daughters whose parents were in the top tier of occupations now work in occupations that score 76 or higher (on a 100-point scale) while half the sons and daughters of parents from the bottom tier now work in occupations that score 28 or less on that scale.

Hout notes that earlier measures -- tracking averages instead of medians -- would underestimate that range and show less stark distinctions between the top and bottom tiers of occupation status.

Specifically, in the above instance, using averages would show half the sons and daughters whose parents were in the top tier of occupations work in occupations that score only 72 or higher while half the sons and daughters of parents from the bottom tier work in occupations that score up to 33 or less.

"Your circumstances at birth -- specifically, what your parents do for a living -- are an even bigger factor in how far you get in life than we had previously realized," observes Hout. "Generations of Americans considered the United States to be a land of opportunity. This research raises some sobering questions about that image."

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Story Source:

Materials provided by **New York University**. *Note: Content may be edited*

for style and length.

Tracking marine migrations across geopolitical boundaries aids conservation -- ScienceDaily

The leatherback sea turtle is the largest living turtle and a critically endangered species. Saving leatherback turtles from extinction in the Pacific Ocean will require a lot of international cooperation, however, because the massive turtles may visit more than 30 different countries during their migrations.

A new study uses tracking data for 14 species of migratory marine predators, from leatherback turtles to blue whales and white sharks, to show how their movements relate to the geopolitical boundaries of the Pacific Ocean. The results provide critical information for designing international cooperative agreements needed to manage these species.

"If a species spends most of its time in the jurisdiction of one or two countries, conservation and management is a much easier issue than it is for species that migrate through many different countries," said Daniel Costa, professor of ecology and evolutionary biology at UC Santa Cruz and a coauthor of the study, published September 3 in *Nature Ecology & Evolution*.

"For these highly migratory species, we wanted to know how many jurisdictional regions they go through and how much time they spend in the open ocean beyond the jurisdiction of any one country," Costa said.

Under international law, every coastal nation can establish an exclusive economic zone (EEZ) extending up to 200 nautical miles from shore, giving it exclusive rights to exploit resources and regulate fisheries within that zone. The high seas beyond the EEZs are a global commons and are among the least protected areas on Earth. Discussions have been under way at the United Nations since 2016 to negotiate a global treaty for conservation and management of the high seas.

First author Autumn-Lynn Harrison, now at the Smithsonian Conservation Biology Institute in Washington, D.C., began the study as a graduate student in Costa's lab at UC Santa Cruz. Costa is a cofounder, with coauthor Barbara Block of Stanford University, of the Tagging of Pacific Predators (TOPP) program, which began tracking the movements of top ocean predators throughout the Pacific Ocean in 2000. Harrison wanted to use the TOPP data to address conservation issues, and as she looked at the data she began wondering how many countries the animals migrate through.

"I wanted to see if we could predict when during the year a species would be in the waters of a particular country," Harrison said. "Some of these animals are mostly hidden beneath the sea, so being able to show with tracking data which countries they are in can help us understand who should be cooperating to manage these species."

Harrison also began attending meetings on issues related to the high seas, which focused her attention on the time migratory species spend in these relatively unregulated waters. "Figuring out how much time these animals spend in the high seas was directly motivated by questions I was being asked by policy makers who are interested in high seas conservation," she said.

The TOPP data set, part of the global Census of Marine Life, is one of the most extensive data sets available on the movements of large marine animals. Many of the top predators in the oceans are declining or threatened, partly because their mobility exposes them to a wide array of threats in different parts of the ocean.

Leatherback turtle populations in the Pacific could face a 96 percent decline by 2040, according to the IUCN Red List of Threatened Species, and leatherbacks are a priority species for the National Oceanic and Atmospheric Administration (NOAA). Laysan and black-footed albatrosses, both listed as near threatened on the IUCN Red List, spend most of their time on the high seas, where they are vulnerable to being inadvertently caught on long lines during commercial fishing operations.

White sharks are protected in U.S. and Mexican waters, but the TOPP data show that they spend about 60 percent of their time in the high seas. Pacific bluefin tuna, leatherback turtles, Laysan albatross, and sooty shearwaters all

travel across the Pacific Ocean during their migrations.

"Bluefin tuna breed in the western North Pacific, then cross the Pacific Ocean to feed in the California Current off the United States and Mexico," Costa said. "Sooty shearwaters not only cross the open ocean, they use the entire Pacific Ocean from north to south and go through the jurisdictions of more than 30 different countries."

International cooperation has led to agreements for managing some of these migratory species, in some cases through regional fisheries management organizations. The Inter-American Tropical Tuna Commission (IATTC), for example, oversees conservation and management of tunas and other marine resources in the eastern Pacific Ocean.

The first session of a U.N. Intergovernmental Conference to negotiate an international agreement on the conservation of marine biological diversity beyond areas of national jurisdiction will be held in September. Harrison said she has already been asked to provide preprints and figures from the paper for this session.

"These migratory species are a shared heritage, and this paper shows their international travels better than ever before," Harrison said. "The first step to protect them is knowing where they are over their annual cycle and promoting international agreements to manage the threats they may face across several countries."

Age, race or need for instant gratification -- which best predicts how much you will earn? -- ScienceDaily

For the first time, Temple University researchers have used machine learning to rank the most important determinants of future affluence. Education and occupation were the best predictors -- but surprisingly, a person's ability to delay instant gratification was also among the most important determinants of higher income, beating age, race, ethnicity and height. Published in *Frontiers in Psychology*, the study suggests that interventions to improve this "delay discounting" could have literal payoffs in terms of higher income attainment.

Many factors are related to how much money a person will earn, including age, occupation, education, gender, ethnicity and even height. Behavioral variables are also implicated, such as one relating to the famous "marshmallow test." This study of delay discounting, or how much a person discounts the value of future rewards compared to immediate ones, showed children with greater self-control were more likely to have higher salaries later in life.

But the study's lead author, Dr William Hampton, now at the University of St. Gallen in Switzerland, says more traditional ways of analyzing data have been unable to indicate which of these factors are more important than others.

"All sorts of things predict income. We knew that this behavioral variable, delay discounting, was also predictive -- but we were really curious how it would stack up against more common-sense predictors like education and age. Using machine learning, our study was the first to create a validated rank ordering of age, occupation, education, geographic location, gender, race, ethnicity, height, age and delay discounting in income prediction."

Traditional methods used by psychologists (such as correlations and regression) haven't allowed for a simultaneous comparison of different

factors relating to an individual's affluence. This study collected a large amount of data -- from more than 2,500 diverse participants -- and split them into a training set and a test set. The test set was put aside while the training set produced model results. The researchers then went back to the test set to test the accuracy of their findings.

Unsurprisingly, the models indicated that occupation and education were the best predictors of high income, followed by location (as determined by zip code) and gender -- with males earning more than females. Delay discounting was the next most-important factor, being more predictive than age, race, ethnicity or height.

Dr Hampton hopes the research approach will be part of a new era in data analysis. "This was amazing because it allowed us to check our findings and replicate them, giving us much greater confidence that they were accurate. This is particularly important given the recent wave of findings across science that do not seem to replicate. Using this machine learning approach could lead to more research that replicates -- and we hope this spurs the use of more sophisticated analytic approaches in general."

The study's authors caution that the data sample was purposely limited to the United States and it is possible that the rank order of variables that predict salary may differ in other countries. Dr Hampton says he is looking forward to exploring this analytical approach in a broader context.

"I would love to see a replication of this study in another culture. I also would be very interested in future studies aiming to reduce delay discounting. There is much debate about whether delay discounting is a stable trait or whether it is malleable -- longitudinal studies could help settle that."

Finally, Dr Hampton has an interesting observation for parents, "if you want your child to grow up to earn a good salary, consider instilling in them the importance of passing on smaller, immediate rewards in favor of larger ones that they have to wait for. This is probably easier said than done, as very few people naturally enjoy waiting, but our results suggest that those who develop the ability to delay gratification are likely investing in their own earning potential."

Story Source:

Materials provided by **Frontiers**. *Note: Content may be edited for style and length.*

The low impact of the high-speed train on international tourism -- ScienceDaily

At the height of the tourist season, a study by the Applied Economics & Management, Research Group, based at the University of Seville, is a pioneering analysis of the relationship between the high-speed train and tourism in Europe, in contrast with tourism's relationship with the plane.

For the Economics Professor, José Ignacio Castillo Manzano, there is undeniably a complementary relationship between air travel and the high-speed train, which would justify the development of joint strategies, starting with rail connections between airports and railway stations with high-speed connections, and going as far as joint plane and high-speed train tickets, as are already sold by one airline. However, and although both means of transport favour tourism, European experience indicates that their influence is very different.

The plane has a close and direct relationship with both national and international tourism. Additionally, not only is it related to a higher volume of visitors, but there is also a relationship with longer stays, especially for international tourism.

In contrast, according to Castillo Manzano, "the relationship the high-speed train has is mostly with national tourism, and it lacks any significant influence on international tourism." For the professor, in the case of Spain, "a larger presence of foreign tourists on the AVE in Spain would act as a mere optical illusion on the supposed relevance of this means of transport on international tourism as, really, the great majority of these tourists have come via the many and cheap flight connections that our airports offer. If the AVE network did not exist, these tourists would instead travel around the country using the greater number of and more frequent domestic flight connections that would exist if the AVE wasn't there." According to this study, there is not even any empirical evidence that, thanks to high-speed train connections, foreign tourists extend their stays in the country.

Of course, the relationship of the high-speed train with national tourism is much closer and more positive than the plane's. But, for Castillo Manzano, the share of earnings that are generated by our high-speed train in the fomentation of domestic tourism remains to be studied. Giving as an example the first AVE line between Madrid and Seville, he explains that "although there is no doubt that this was very important in Seville being able to attract many more tourists from the centre of the peninsula, especially in the nineties, while the planned high-speed train network has been developed, incorporating new cities, it is very probable that the more significant part of the money earned goes to Madrid. Doubtlessly, what has happened is a significant improvement in access facilities from our country's main cities to the capital. Thanks to the AVE, Madrid is now the easiest place to organise a national conference, a work meeting or for ordinary Spanish people to have a weekend break to, for example, see a musical or a new exhibition at the Prado. However, tourists that come from Madrid do not only head for Seville, rather they visit different cities on the AVE."

On the other hand, the study also concludes that those countries with a lower per capita income and lower prices in the tourist sector are those that attract more foreign tourists, whereas the more developed a country is, the more national tourism it generates. So, for the professor, encouraging the economic development of a country is also a magnificent policy for promoting domestic tourism.

In contrast, if we are speaking about attracting foreign tourism, for Castillo good airport management and infrastructure is fundamental. "There are few more effective tourism policies than the setting of optimal airport taxes that favour the opening of new routes and increased flight frequency and combat the highly seasonal nature of the tourism industry." In this way, "the good working of the pairing of transport and tourism is the best guarantee of the future of the sector, hence the need to contribute to finding long-term solutions to problems related to transport that threaten, as with the taxi sector, systemic delays at some airports, or labour problems as experienced by Ryanair."

Story Source:

Materials provided by **University of Seville**. *Note: Content may be edited for*

style and length.

Sharp rise in essay cheating globally, with millions of students involved -- ScienceDaily

A breakthrough study by Swansea University has revealed that the use of contract cheating, where students pay someone else to write their assignments, is rising rapidly around the world.

For the study, published in *Frontiers in Education*, Professor Phil Newton from Swansea University, analysed 71 survey samples from 65 studies dating back as far as 1978, covering 54,514 participants.

Because the products of essay-mills are designed to be difficult to detect, it is hard to develop objective measures of contract cheating. This new study therefore systematically reviewed findings from prior 'self-report' research papers; questionnaire based studies wherein students were asked if they had ever paid someone else to undertake work for them.

The findings of the research show that as many as one in seven recent graduates may have paid someone to undertake their assignment for them, potentially representing 31 million students across the globe.

Across the sample, contract cheating was self-reported by a historic average of 3.5% of students, but this was shown to be increasing significantly over time. In studies from 2014 to present, the percentage of students admitting to paying someone else to undertake their work was 15.7%. Cheating, in general, also appeared to be on the rise according to the studies reviewed.

Professor Newton suggests that the data he found is actually likely to underestimate levels of contract cheating, for the simple reason that students who engage in contract cheating are less likely to volunteer to participate in surveys about cheating.

Essay-mills are currently legal in the UK, although they are banned in the USA and New Zealand, while other countries are actively developing

legislation. Professor Newton warns: "The UK risks becoming a country where essay-mills find it easy to do business."

Commenting on the results of his research, Professor Newton, director of learning and teaching at Swansea University Medical School, says:

"These findings underscore the need for legislation to tackle essay-mills, alongside improvements in the way students are assessed and awareness-raising of the fundamentals of academic integrity. We need to utilise assessment methods that promote learning and at the same time reduce the likelihood that contract cheating can happen."

A proposal for a new law emerged from previous research by Professor Newton, in collaboration with Professor Michael Draper from the Hillary Rodham Clinton School of Law at Swansea University. The proposal came from their earlier study, which concluded that existing UK laws would not be effective in tackling Essay Mills. There is currently an active petition calling for the government to introduce a new law.

Both Professor Newton and Professor Draper were authors of a report issued by the Quality Assurance Agency (QAA) last year, which contained advice and guidance for higher education providers and staff on many different approaches to contract cheating. Earlier research from Professor Newton showed that academic integrity is not a topic that is routinely covered in teacher training programmes for staff and that students have a poor understanding of the consequences of engaging in contract cheating.

Story Source:

Materials provided by **Swansea University**. *Note: Content may be edited for style and length.*

Using physics to predict crowd behavior -- ScienceDaily

Electrons whizzing around each other and humans crammed together at a political rally don't seem to have much in common, but researchers at Cornell are connecting the dots.

They've developed a highly accurate mathematical approach to predict the behavior of crowds of living creatures, using Nobel Prize-winning methods originally developed to study large collections of quantum mechanically interacting electrons. The implications for the study of human behavior are profound, according to the researchers.

For example, by using publicly available video data of crowds in public spaces, their approach could predict how people would distribute themselves under extreme crowding. By measuring density fluctuations using a smartphone app, the approach could describe the current behavioral state or mood of a crowd, providing an early warning system for crowds shifting toward dangerous behavior.

Tomas Arias, professor of physics, is lead author of "Density-Functional Fluctuation Theory of Crowds," which published Aug. 30 in *Nature Communications*. Co-authors include Itai Cohen, professor of physics; and Yunus A. Kinkhabwala, a doctoral student in the field of engineering.

Interactions among individuals in a crowd can be complex and difficult to quantify mathematically; the large number of actors in a crowd results in a complex mathematical problem. The researchers sought to predict the behavior of crowds by using simple measurements of density to infer underlying interactions and to use those interactions to predict new behaviors.

To achieve this, they applied mathematical concepts and approaches from density-functional theory (DFT), a branch of many-body physics developed for quantum mechanical systems, to the behavior of crowds.

"This is one of the all-too-rare cases -- particularly where living systems are involved -- where the theory preceded the experiments, and the experiments, in precise mathematical detail, completely confirmed the theory," said Arias.

To test their theory, the researchers created a model system using walking fruit flies (*Drosophila melanogaster*). They first demonstrated a mathematical way to extract functions that quantify how much the flies like different locations in their environment -- the "vexation" function -- and how much they mind crowding together -- the "frustration" function based on the details of how the population densities change as the flies more around.

They then showed that by mixing and matching this information with observations of a single fly in an entirely new environment, they could accurately predict, before any observations, how a large crowd of flies would distribute themselves in that new environment. They also tracked changes in the overall behavior of the crowd -- i.e., its "mood" -- by tracking evolution of the social preference "frustration" function.

While fruit flies were "a convenient, and ethical, first test system," Arias said, the behavior of a crowd at a political rally would provide a human example of DFT theory. Individuals will try to find the best location to stand -- typically closest to the stage -- while avoiding overcrowded areas. When new and better locations become available, individuals are likely to move toward them.

To develop a mathematically predictive theory, the researchers associated a number -- the vexation function -- with the intrinsic desirability of each location; the lowest value would be at the ideal location, closest to the stage. The frustration function accounts for the undesirability of crowding effects, and a behavioral rule accounts for the tendency of individuals to look for better locations.

"The remarkable mathematical discovery," Arias said, "is that precise values for vexation and frustration can be obtained instantly and automatically, simply by observing changes in crowding as the crowd mills around, without the need for any kind of survey to ask people in the crowd how they feel about different locations or crowding together."

By varying the social circumstances in their fly experiments -- such as changing the ratio of male and female, or inducing hunger and thirst -- and monitoring the frustration values of the crowd, the researchers showed they can detect changes in the "mood" of the crowd. The DFT approach, therefore, not only predicts crowd behaviors under new circumstances, but also can be used to quickly and automatically detect changes in social behaviors.

Another application, using cell-phone and census data, could analyze political or economic drivers and population pressures to describe and predict large-scale population flows, such as mass migrations. "The resulting predictions of migration during acute events would enable better planning by all levels of government officials, from local municipalities to international bodies, with the potential to save millions of human lives," note the researchers.

Other contributors included J. Felipe Méndez-Valderrama, professor of physics, University of Los Andes, Bogota, Colombia; and Jeffrey Silver, senior analyst at Metron Inc.

Countries ranked by oil production emissions -- ScienceDaily

Until renewable sources of energy like wind or solar become more reliable and less expensive, people worldwide remain reliant on fossil fuels for transportation and energy. This means that if people want to reduce greenhouse gas emissions, there need to be better ways of mitigating the effects of extracting and burning oil and gas.

Now, Adam Brandt, assistant professor of energy resources engineering in the School of Earth, Energy & Environmental Sciences at Stanford, and his colleagues have performed a first global analysis comparing emissions associated with oil production techniques -- a step toward developing policies that could reduce those emissions. They published their work Aug. 30 in *Science*.

The group found that the burning of unwanted gas associated with oil production -- called flaring -- remains the most carbon-intensive part of producing oil. Brandt spoke with *Stanford Report* about the group's findings and strategies for reducing flaring.

What is flaring and why is it especially important to track?

Oil and gas are generally produced together. If there are nearby gas pipelines, then power plants, factories, businesses and homes can consume the gas. However, if you're very far offshore or can't get the gas to market, there's often no economically feasible outlet for the gas. In this case, companies want to get rid of the gas, so they often burn -- or flare -- it.

Thankfully, there is some value to the gas, so there can be some savings associated with stopping flaring. I think setting the expectation that the gas will be managed properly is the role of the regulatory environment. There are some efforts underway to try to tackle this -- the World Bank has a big effort called the Global Gas Flaring Reduction Partnership, where companies have

banded together to try to set flaring targets, so hopefully this will start to decline.

This work represents the first study breaking down oil-industry greenhouse gas emissions at the country level. What data did you look at to do this work?

This is the culmination of a larger project we've been working on for eight or so years. We used three different data sources. For some countries you can get data from governmental sources or regulatory agencies. Environmental agencies and natural resource agencies will also report information we can use. Otherwise, we go to petroleum engineering literature to get information about oil fields. Then we were able to collaborate with Aramco, an international oil company, to access a commercial data set. That allowed us to fill in gaps for a lot of smaller projects that are harder to get information on or the data gathering was just too intensive. With that, our paper covers about 98 percent of global oil supply. Necessarily, it's the first time we've been able to do this at this very resolved oil field-by-oil field level.

In mapping the world's oil supply, how did you estimate emissions from flaring on a country-by-country basis?

One of the challenges with flaring is that most countries don't report it. In many countries, we ended up using country-level average satellite data collected by the National Oceanic and Atmospheric Administration. Scientists there have developed ways to estimate the amount of gas flared using the brightness of the flare as seen from space. It's essentially an eye in the sky. For instance, Russia won't say how much they are flaring, but we can see it from the satellite.

Where have you seen flaring regulations work?

Offshore Canada has had a good success over the last 15 years. Basically, the rules there say that you're not allowed to flare above a certain amount. If flaring goes above a permitted level, Canada requires their offshore fields to shut down until they handle the gas. This can be done by reinjecting it back into the ground, converting it to liquefied natural gas or installing gas pipelines to get the gas to customers. Canadian flaring has dropped significantly, and these regulations prove that you can manage flaring and

require that people do something productive with the gas or put it back underground. Really, the challenge with flaring is there needs to be a policy or a regulatory apparatus to say, "Burning gas with no purpose isn't allowed; put it back in the ground or find something useful to do with it."

In the absence of federal action, how can we prioritize flaring reductions here in the U.S.?

If you don't see action at the U.S. federal level, you can work with leadership from state agencies. A good example of this was the state of North Dakota. North Dakota contains the Bakken Formation, which is one of the main regions for producing oil from hydraulically fractured wells. Five years ago, 30 percent of the gas being produced was being flared, and essentially the state government said this is not acceptable. Thirty percent was way too high and the gas had value -- it could be sold to cities like Chicago, Calgary or Denver. The government set a target for 10 percent, with the threat of potential production restrictions if producers didn't meet the target. So what happened? Producers in the region actually met the 10 percent target ahead of time. So I think things can keep moving forward. Obviously, it'd be better if we had some sort of federal action on this, but states can do a lot.

Who can drive the change needed across the globe?

Globally, I think international oil companies can really take the lead. A lot of the projects with flaring are in countries where environmental issues are poorly regulated. But many of these projects are developed by the local national oil company in cooperation with international partners. It's hard to wait on developing countries without large budgets or sophisticated regulatory capacity to put flaring rules into place. Instead of waiting for that to happen, we might expect the international oil companies work to solve the problems themselves by applying best practices from places were regulations have already solved the problem. For example, companies in Nigeria have increased gas reinjection and developed liquefied natural gas projects to get the gas to markets.

In the coming decades, we are going to be using a lot of oil and gas. It's inevitable. Taking best practices and applying them in places that are not as well regulated right now -- but hopefully will be -- can allow improvements

in one region to benefit another region.

Hopefully, we'll transition as quickly as possible to renewables, but while we use oil and gas in the meantime, let's do it responsibly.

The work was funded by the Natural Sciences and Engineering Research Council of Canada, Aramco Services Co., Ford Motor Co., the Carnegie Endowment for International Peace, the Hewlett Foundation, the ClimateWorks Foundation and the Alfred P. Sloan Foundation.

New survey reveals 57 percent of Americans have been surprised by a medical bill: The public holds insurers and hospitals most accountable when they receive an unexpected charge -- ScienceDaily

Fifty-seven percent of American adults have been surprised by a medical bill that they thought would have been covered by insurance, according to a new AmeriSpeak® survey from NORC at the University of Chicago. Respondents indicated that 20% of their surprise bills were a result of a doctor not being part of the network.

Among those surveyed who indicated that they had been surprised by medical bills in the past, the charges were most often for physician services (53%) followed closely by laboratory tests (51%). Other common sources of surprise bills were hospitals or other health care facility charges (43%), imaging (35%), and prescription drugs (29%).

Surprise medical bills may occur for several reasons. In some cases, particular services (e.g., certain lab tests) or products (e.g., certain prescription drugs) may not be covered by a health plan. Care received before meeting the deductible or high cost-sharing requirements may also surprise consumers. In other cases, health care providers may be out-of-network for a plan. When that occurs, charges for the services may only be partially covered or not covered at all, depending on the type of insurance and benefit design.

"Most Americans have been surprised by medical bills that they expected would be covered by their insurance," said Caroline Pearson, senior fellow at NORC at the University of Chicago. "This suggests that consumers may have difficulty understanding their insurance benefits or knowing which providers are included in their plan's network."

The public holds insurers and hospitals most accountable for surprise medical bills.

When asked which groups are most responsible for surprise medical bills, 86% of respondents said insurance companies are "very" or "somewhat" responsible, while 82% said hospitals were "very" or "somewhat" responsible. Respondents were less likely to hold their doctors responsible, with 71% saying doctors are "very" or "somewhat" responsible for surprise bills.

"While consumers report that physician services are the most common source of their surprise bills, they are most likely to blame insurers for those bills," said Michelle Strollo, Vice President at NORC.

Methodology

The poll included 1,002 interviews with a nationally representative sample of Americans using the AmeriSpeak® Panel. AmeriSpeak® is NORC's probability-based panel designed to be representative of the U.S. household population. During the initial recruitment phase of the panel, randomly selected U.S. households were sampled with a known, non-zero probability of selection from the NORC National Sample Frame and then contacted by U.S. mail, email, telephone, and field interviewers (face-to-face). The panel provides sample coverage of approximately 97 percent of the U.S. household population. Those excluded from the sample include people with P.O. Box only addresses, some addresses not listed in the USPS Delivery Sequence File, and some newly constructed dwellings. Interviews for this survey were conducted between August 16 and August 20, 2018, with adults age 18 and older representing the 50 states and the District of Columbia. A comprehensive listing of all study questions, complete with tabulations of top-level results for each question, is available here.

Story Source:

Materials provided by **NORC at the University of Chicago**. *Note: Content may be edited for style and length.*

https://www.sciencedaily.com/releases/2018/08/180830143045.htm

Selling access to human specimens: Survey reveals public attitudes -- ScienceDaily

The almost 5 million people who paid to get their DNA analyzed by the company 23andMe recently found out that their genetic data and related health information might have been sold to a major drug company.

That's because 23andMe made a $300 million deal with pharmaceutical giant Glaxo SmithKline, to let it tap that genetic goldmine to help it develop new medicines. If 23andMe customers consented to allow their DNA samples to be used for research when they sent them in, their data can be sold in this way.

Millions more people have samples sitting in very different kinds of biobanks: at universities and major teaching hospitals. When patients have surgery, biopsies, or blood draws at hospitals, those specimens may be kept for future research.

A new University of Michigan survey documents public attitudes toward potential commercial use of these samples.

A new survey reveals what members of the public think about such deals, and what they would want to know if their specimen were part of one, even if it didn't have their name attached. The results are published in a new paper in the August issue of the journal *Health Affairs*, by a team of U-M bioethics researchers from the Medical School and School of Public Health.

Only one in four of the 886 people surveyed nationally said they'd be comfortable with companies getting access to their leftover specimens from a university or hospital biobank.

Two thirds of the survey respondents said that if such a deal happened, they'd want to know. If the specimens in academic biobanks don't include patients' identifying information, researchers don't need informed consent from the

patient in order to keep them for research. However, as Andrew Shuman, M.D., a head and neck surgeon and co-chief of the Clinical Ethics Service of the Center for Bioethics & Social Sciences in Medicine points out, "there are compelling reasons to ask for patient consent before we collect specimens for research -- whether or not their identifiable health information is included."

Nonprofit institutions, like academic medical centers, usually use these samples for research. But often they need to look elsewhere for funding to support the upkeep of the biobank -- and may sell access to private companies through a process called commercialization.

"That's a big part of the business model of the direct-to-consumer genetic testing companies" points out U-M faculty member and co-author Michele Gornick, Ph.D., but it was not the driving force behind the creation of academic biobanks.

As more academic institutions seek to commercialize their biobanks, the U-M team asked survey respondents what universities and hospitals should do with the money they might get from such deals.

Sixty-two percent said they should plow those funds back into more research. The U-M researchers argue in the new article that these findings demonstrate that when researchers are asking for informed consent to biobank donation, they should also disclose what the money will be used for in the future.

The findings have real-world implications, says Jody Platt, PhD, the study's senior author and assistant professor in the Medical School. Under the new regulations, public biobanks will often be required to disclose to patients if specimens will be commercialized in the future.

"We found that if you disclose commercial interests, people are less likely to participate," says Platt. "But if you also tell them that the money will be reinvested in research, this will reengage trust and encourage participation."

Their findings suggest that institutions should go above and beyond what the law requires, under the newly revised Federal Policy for the Protection of Human Subjects, or "Common Rule," that takes effect in January.

The survey, done as part of a larger one led by co-author Sharon Kardia, Ph.D. of the U-M School of Public Health, and also with U-M medical school faculty Raymond De Vries, Ph.D., included a nationally representative sample of adults who were presented a scenario about biobanking and commercialization, and then answered questions online.

"The new disclosure laws are supposed to be a floor, not a ceiling," says lead author Kayte Spector-Bagdady, J.D, MBE, who is Chief of the Research Ethics Service at CBSSM. "But it may be counter-intuitive for biobanks to disclose more information than legally required. Here we found that they should be doing just that."

Spector-Bagdady, Platt, Shuman and Gornick are members of the U-M Institute for Healthcare Policy and Innovation.

Information technology jobs outpace most other jobs in productivity and growth since 2004 -- ScienceDaily

Jobs in information technology-like computer software, big data, and cybersecurity-are providing American workers with long-lasting financial stability, suggests a new study from the University of British Columbia and the Massachusetts Institute of Technology.

"The future of jobs is in IT, and IT-intensive tasks" said Giovanni Gallipoli, co-author and associate professor from the Vancouver School of Economics at UBC. "Growth and productivity in jobs involving IT tasks are very strong, and workers who can perform such tasks have a clear competitive advantage in the labour market."

The study reveals the well documented slow-down in employment and wage gains associated with skills and education that has been recorded after the year 2000 is in fact not occurring at all for jobs that involve IT. The share of these jobs has increased substantially over the past two decades, with IT-intensive occupations growing by 19.5 per cent between 2004 and 2017. Less IT-intensive occupations only grew by 2.4 per cent over the same period. The growth in IT jobs is more than eight times the growth rate than for other jobs over the past decade.

"While there is clear evidence that earnings growth for Americans with college degrees has somewhat flattened since 2000, earnings have actually grown significantly for individuals working in jobs involving IT tasks," said Gallipoli. "Both companies and workers stand to benefit if they invest in IT education."

Despite the decline in traditional manufacturing jobs from automation or off-shoring, the study also shows that a subset of jobs in manufacturing that involve IT tasks have increased in number, as well as having high

productivity growth and returns.

According to the researchers, the rise of IT has changed the nature of employment in the manufacturing sector, creating a greater demand for workers with computing and technical expertise.

"Companies often report troubles finding enough workers for IT-intensive tasks," said MIT's Christos Makridis, the study's co-author. "This suggests the presence of a skills gap for jobs with digital and technical requirements. The insufficient number of job candidates able to perform complex IT tasks suggests the possibility of workers' mismatches in the labour market. It also suggests the need for additional training, whether formal or on the job, like apprenticeships, that focuses on the skills that are most in demand."

While much of the debate around automation and the role of technology in employment today focuses on its impact on jobs, or how workers stand to be replaced by robots, the researchers stress greater focus needs to be paid to its effects on productivity, wages and the ongoing structural change in the labour market of both manufacturing and services.

"Our research starts to highlight these sizable effects, and the growth in employment demand for certain IT-intensive tasks cannot be easily automated or offshored," Gallipoli said. "The emergence of IT intensive jobs has had a major impact on the structure and on the distribution of wages both within and across sectors."

"As the cost of collecting and processing information continues declining, every company is going to turn into a data science company, whether they like it or not," said Makridis. "That is only going to raise the demand for information technology workers."

The study, Structural Transformation and the Rise of Information Technology, is published in the *Journal of Monetary Economics*.

Story Source:

Materials provided by **University of British Columbia**. *Note: Content may be edited for style and length.*

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When God is your only friend: Religion and the socially disconnected -- ScienceDaily

Religious people who lack friends and purpose in life turn to God to fill those voids, according to new University of Michigan research.

Belonging is related to a sense of purpose. When people feel like they do not belong or unsupported by their relationships, they consistently have a lower sense of purpose and direction in life, says lead author Todd Chan, a doctoral student in the U-M Department of Psychology.

Chan and colleagues say that having a belief system that adequately "substitutes" for some of the functions of human relationships, like having a God that values and supports them, may allow socially disconnected people to restore some of this purpose.

"For the socially disconnected, God may serve as a substitutive relationship that compensates for some of the purpose that human relationships would normally provide," Chan said.

In three separate studies, the U-M researchers analyze the responses from 19,775 people who described their purpose in life, levels of loneliness, the quality of their friendships and religious beliefs.

These beliefs generally provide social comfort. The research shows that seeing God as your friend when you are already socially connected actually provides minimal additional benefit for purpose in life.

"In other words, people mostly benefit from leveraging religion and turning to God as a friend only when they lack supportive social connections," Chan said.

This research also informs how people can cope with disconnection when other people are unavailable or unappealing. To feel less disconnected,

people would ideally "get out there" and improve their social contacts, but this is not always feasible given that an inherent part of social disconnection is that people have poor relationships or are rejected, the researchers say.

The new U-M study continues previous research showing that people who are socially disconnected are more likely to see human-like qualities in things like pets, imaginary beings and God.

"Our research suggests, given two people who feel equally disconnected, the individual who feels more connected to God will have a better sense of purpose in life," said co-author Nicholas Michalak, a psychology graduate student.

Although the results suggest that religion and God compensate for lost purpose in the socially disconnected, it did not restore purpose to a level comparable to that of people who are socially connected.

"These results certainly do not suggest that people can or should rely on God over people for purpose," said co-author Oscar Ybarra, professor of psychology and faculty associate at the U-M Institute for Social Research. "Quality human connections still remain a primary and enduring source of purpose in life."

In addition, the findings do not suggest that people who are socially disconnected are more likely to become religious if they were not already.

The study appeared in the *Journal of Personality*.

Story Source:

Materials provided by **University of Michigan**. *Note: Content may be edited for style and length.*

Financial disclosure lacking in publication of clinical trials, study finds -- ScienceDaily

A substantial proportion of pharmaceutical industry payments to authors of oncology clinical trials published in major scientific journals are not disclosed, new research shows. The publications focused on clinical trials that tested new cancer drugs.

The new findings will be published as a research letter in the journal *JAMA Oncology*.

Authors of the research letter examined the federal Open Payments Database to determine payments to oncologists who authored studies in high-impact journals. They then cross-checked the information to determine whether the authors properly disclosed the funding when the results of their clinical trials were published in scientific journals. Depending on the journal, almost half of total funding was not disclosed.

"It's the honor system," said co-author Erick Turner, M.D., associate professor of psychiatry in the OHSU School of Medicine and senior scholar with the Center for Ethics in Health Care at OHSU in Portland, Oregon. "The journals ask the authors to make these disclosures, but there's no legal force behind it."

Previous studies have investigated funding disclosures among the authors of clinical practice guidelines. However, this is the first study to examine financial conflict of interest in the publication of clinical trials that underpin FDA approval of new oncology drugs.

Payments from pharmaceutical companies have been shown to change physician prescribing practices, researchers noted.

"We know that pharmaceutical companies sponsor trials of their own drugs. That's not a surprise," said lead author Cole Wayant, D.O., Ph.D., researcher

at Oklahoma State University. "But what is a surprise, and what warrants concern, is that this funding is often not disclosed in the publication of clinical trials that form the basis of FDA approvals and clinical practice guidelines."

The researchers identified 344 oncologist-authors of clinical trials associated with oncology drugs approved between Jan. 1, 2016, and Aug. 31, 2017. Cumulatively, the 344 oncologist authors received a total of $216 million in four categories of payments: Speaking fees and other general payments; research for study coordination; research grants, and ownership through stock payments.

The authors then compared disclosure of financial conflict of interest in clinical trials published in six high-impact scientific journals: The *New England Journal of Medicine*, *The Lancet*, *The Lancet Oncology*, *The Lancet Haematology*, the *Journal of Clinical Oncology*, and *JAMA Oncology*. Almost a third of the oncologist-authors (a total of 110) did not fully disclose payments, the study found.

"In clinical trials of FDA-approved oncology drugs, bias, either real or potential, is more concerning because these oncology drugs are often associated with marginal improvement in survival but exorbitant costs," the authors wrote.

Story Source:

Materials provided by **Oregon Health & Science University**. Original written by Erik Robinson. *Note: Content may be edited for style and length.*

The god of small things -- ScienceDaily

New research suggests people who are religious gain happiness from believing there is a deeper meaning to everyday events.

Dr Jonathan Ramsay is a Senior Lecturer in psychology at James Cook University's Singapore campus, with a particular interest in the psychology of religion.

His team surveyed 231 people from a diverse mix of Christians, Buddhists or Taoists, Muslims and people with no religious affiliation.

Dr Ramsay said all world religions believe that the universe has an underlying order and structure that gives greater meaning or significance to events and circumstances.

"What we were interested in is if the believer interprets events in this fashion, does it influence their emotional reaction to those events, and eventually their general sense of well-being?"

Dr Ramsay said the results show that all people, but especially religious people, regularly assign significance to unremarkable events -- such as discussing hobbies with a work colleague, receiving a small but unexpected gift, or spending time with a family member.

"We found the more people gave meaning, purpose, and significance to such events the more they experienced positive emotions such as gratitude and contentment," he said.

Dr Ramsay said previous research had shown a link between meaningfulness and religion and well-being, but this was the first study to examine the emotional consequences of giving meaning to otherwise insignificant events, and also the first to investigate this process in immediate, moment-to-moment experience.

"The relationship between religion and well-being is well-known. Our results tentatively suggest that the positive effect of religious belief on well-being via the giving of meaning to events and the resulting positive emotions is a general phenomenon that holds across religious and ethnic groups," he said.

Story Source:

Materials provided by **James Cook University**. *Note: Content may be edited for style and length.*

Mongrel Mob gang opens up to New Zealand researchers for the good of their health -- ScienceDaily

Studying the liver health of a high-risk, hard-to-reach gang population certainly came with challenges and a few surprises, a University of Otago academic says.

The research, published today in *Royal Society Open Science*, assessed the hepatitis prevalence, knowledge, and liver health risk factors of 52 Mongrel Mob members, affiliates and extended family.

Associate Professor Michael Schultz, Head of the Department of Medicine, says New Zealand has a high percentage of undiagnosed hepatitis B and C cases.

The Mongrel Mob is the largest gang in New Zealand and, thanks to known risk factors for hepatitis C, such as a high incarceration rate, common intravenous drug use, and uncertified tattooing, their members and relatives are considered to be a high-risk hepatitis C group.

"Knowledge of hepatitis and how it is transmitted are essential for disease prevention and management," he says.

Dr Schultz says the researchers were provided with a unique opportunity to study the Mongrel Mob, a group considered to be hard-to-reach and marginalised, generating the first data of this kind.

While no cases of hepatitis C were found, two carriers of hepatitis B were identified.

Of most concern was the "marginal" knowledge the study participants had about viral hepatitis. On average, the participants scored 43.3 per cent on a knowledge questionnaire, compared to 59.4 per cent in the general

population.

"Knowledge about some aspects of viral hepatitis, such as risk factors, transmission, symptoms and treatment options was very low," Dr Schultz says.

The researchers found a significant link between lack of knowledge and risky infection behaviours among the group.

"Education is key to stopping hepatitis C from spreading. This study demonstrates the need for educational screening programmes to aid early detection, prevention and treatment," he says.

The researchers also identified several areas of concern about the general liver health of the group: participants displayed three times higher rates of liver inflammation and damage compared to the general population; one-fifth had significant to severe levels of liver fibrosis and cirrhosis; exceptionally high levels of alcohol consumption, in both frequency and quantity, were identified; and the group was found to have more than two times higher obesity rates than the general population.

"Given that about 35 per cent of the group visited their GP less than once every five years, they are highly concerning findings," Dr Schultz says.

While surprised by the willingness of the participants to be involved in the study, Dr Schultz believed having a person on the team who came from a gang family helped break the ice.

"While the planning wasn't all that easy, once there, everybody was really open, interested, and asked questions. We felt welcome, not threatened at all. They were very nice and co-operative and really interested, despite what we think we know about the Mongrel Mob.

"I see this as one of the most interesting and challenging projects I have done. It certainly took me out of my comfort zone."

He was particularly pleased the study provided a unique opportunity to engage with an entire community, and provide knowledge that disseminated

outside the immediate study group.

The Mongrel Mob has also worked with Otago academics to study lung function and smoking habits. Dr Schultz believes there is scope to also work with the gang on projects targeting diabetes and hypertension, though nothing is currently planned.

As it proved such a successful model for community-based educational health intervention, the study format could also be extended to other subjects.

"With some persistence and good planning, it is possible to reach these people."

Deadline for climate action: Act strongly before 2035 to keep warming below 2°C -- ScienceDaily

If governments don't act decisively by 2035 to fight climate change, humanity could cross a point of no return after which limiting global warming below 2°C in 2100 will be unlikely, according to a new study by scientists in the UK and the Netherlands. The research also shows the deadline to limit warming to 1.5°C has already passed, unless radical climate action is taken. The study is published today in the European Geosciences Union journal *Earth System Dynamics*.

"In our study we show that there are strict deadlines for taking climate action," says Henk Dijkstra, a professor at Utrecht University in the Netherlands and one of the study authors. "We conclude that very little time is left before the Paris targets [to limit global warming to 1.5°C or 2°C] become infeasible even given drastic emission reduction strategies."

Dijkstra and his colleagues at the Utrecht Centre for Complex Systems Studies and at Oxford University, UK, wanted to find the 'point of no return' or deadline for climate action: the latest possible year to start strongly cutting greenhouse-gas emissions before it's too late to avoid dangerous climate change. "The 'point of no return' concept has the advantage of containing time information, which we consider very useful to inform the debate on the urgency of taking climate action," says Matthias Aengenheyster, a doctoral researcher at Oxford University and the study's lead author.

Using information from climate models, the team determined the deadline for starting climate action to keep global warming likely (with a probability of 67%) below 2°C in 2100, depending on how fast humanity can reduce emissions by using more renewable energy. Assuming we could increase the share of renewable energy by 2% every year, we would have to start doing so before 2035 (the point of no return). If we were to reduce emissions at a

faster rate, by increasing the share of renewable energy by 5% each year, we would buy another 10 years.

The researchers caution, however, that even their more modest climate-action scenario is quite ambitious. "The share of renewable energy refers to the share of all energy consumed. This has risen over the course of over two decades from almost nothing in the late nineties to 3.6% in 2017 according to the BP Statistical Review, so the [yearly] increases in the share of renewables have been very small," says Rick van der Ploeg, a professor of economics at Oxford University, who also took part in the *Earth System Dynamics* study. "Considering the slow speed of large-scale political and economic transformations, decisive action is still warranted as the modest-action scenario is a large change compared to current emission rates," he adds.

To likely limit global warming to 1.5°C in 2100, humanity would have to take strong climate action much sooner. We would only have until 2027 to start if we could increase the share of renewables at a rate of 5% a year. We have already passed the point of no return for the more modest climate-action scenario where the share of renewables increases by 2% each year. In this scenario, unless we remove carbon dioxide from the atmosphere, it is no longer possible to achieve the 1.5°C target in 2100 with a probability of 67%.

Removing greenhouse gases from the atmosphere, by using 'negative emissions' technology, could buy us a bit more time, according to the study. But even with strong negative emissions, humanity would only be able to delay the point of no return by 6 to 10 years.

"We hope that 'having a deadline' may stimulate the sense of urgency to act for politicians and policy makers," concludes Dijkstra. "Very little time is left to achieve the Paris targets."

Story Source:

Materials provided by **European Geosciences Union**. *Note: Content may be edited for style and length.*

Better fisheries management could help offset climate change's negative effects, research suggests -- ScienceDaily

If we proactively implement effective fisheries management and limit global temperature rise, the world's oceans still have the potential to be significantly more plentiful in the future than today, despite climate change. This finding is among several that appear in a first-of-its kind study, "Improved fisheries management could offset many negative effects of climate change," that appears today in the American Association for the Advancement of Sciences' journal *Science Advances*.

"The expected global effects of climate change on our oceans are broadly negative," said Steve Gaines, the study's lead author and dean of UC Santa Barbara's Bren School of Environmental Science & Management, "but we still have the fortunate opportunity to turn the tide and create a more bountiful future."

The study finds that with concerted and adaptive responses to climate change, the world's oceans could actually create more abundant fish populations, more food for human consumption and more profit for fishermen despite the negative impacts of climate change. Conversely, the study cautions, inaction on fisheries management and climate change will mean even more dramatic losses of fish and the benefits they provide to people.

A dozen leading scientists from institutions including UCSB's National Center for Ecological Analysis and Synthesis, Hokkaido University and Environmental Defense Fund (EDF) conducted the research. It is the first study to examine future fishery outcomes under both climate change projections and alternative human responses. It demonstrates that our oceans can be highly productive for decades to come if action is taken now to put effective and forward-looking management practices in place.

"The results from this study are surprisingly positive -- if we can adopt sustainable fishing policies and keep global warming at no more than 2 degrees Celsius, we can still realize significant benefits to fisheries across the globe," said Merrick Burden, senior economist with the EDF Oceans program and an author of the paper. "But these benefits require action and this study serves as a wake-up call to governments that they must change the way that fishing takes place or risk losing a crucial opportunity to secure our food supply for generations to come."

This study examines potential future outcomes for 915 fish stocks across the world under alternative management and climate scenarios. The authors modeled the impact of climate change on fishery productivity and geographical range distribution, which affects how many fish are available and where they can be caught, under four climate projections. These range from a global temperature increase of 1 degree Celsius (strong climate mitigation) to an increase of 4 degrees Celsius (business-as-usual) by 2100. For each of these climate scenarios, the authors examined future biomass, harvest and profit under alternative management approaches using bioeconomic modeling.

The new research shows that roughly 50 percent of species examined will shift across national boundaries and nearly all species are expected to experience changes in productivity in response to rising ocean temperatures. These changes will present new challenges for fishing nations. The study found that the implementation of management practices that account for changes in productivity and geographic range distribution can lead to global gains in profits, harvest and biomass compared to today. These practices range from flexible management strategies, including responsible harvest policies that account for changing stock productivity, to the creation and improvement of existing governance institutions to deal with shifting stocks, such as multilateral fishery agreements.

"Cooperation among nations will be increasingly important for ensuring future fisheries benefits as stocks shift across management boundaries," said Tracey Mangin, an author of the paper and researcher at UCSB's Sustainable Fisheries Group, explaining that rising ocean temperatures can send fish stocks beyond their traditional geographical ranges as they track their

preferred thermal habitats. "These shifts can undermine previously effective and well-designed management approaches, as they can incentivize overfishing and change which nations have access to the fish stocks, which can weaken existing fishing agreements."

While improved management may lead to improved global outcomes, those outcomes will vary regionally. The results indicate that future fishery profits are expected to decline in tropical latitudes even with management that fully adapts to climate challenges. This means that equatorial nations, many of which have developing economies and are highly dependent on seafood as a source of food and income, will be hardest hit. And how much planetary warming occurs will make a significant difference on the abundance, harvest and profit from fisheries.

"Even with the right management changes, there will be winners and losers, and we have to tackle this head-on," Gaines said. "Success will require not only emissions reductions but also multilateral cooperation and real changes in fisheries management. With our growing global population and the increasing needs for healthy sources of protein, these changes will be critical for meeting United Nations Sustainable Development Goals."

The impacts of inaction are also clear. Billions of people rely on fish as their primary source of protein. Most fishing nations are not responding fast enough to create change, and successful transboundary management programs are relatively rare. But action doesn't take long to have an impact on some species. Studies have demonstrated that many fisheries can bounce back from overfishing in as little as 10 years' time under the right policies.

"Climate change is expected to hit hardest in many of the places where fisheries are already poorly managed -- things are likely to get a lot worse if we don't act," said Christopher Costello, an author of the paper and a professor of environmental and resource economics at UCSB. "We can expect inaction to bring increased conflict as fish move into new waters, along with threats to food security in some of the world's most vulnerable places."

"Fishermen will be among the most affected by climate change, and this research confirms what they are already seeing on the water," said Katie

McGinty, senior vice president of EDF Oceans. "The window is narrow, but we have the tools and a clear roadmap to build a future with more fish, more food and more prosperity -- if we act now."

The study did not examine other potential threats from climate change such as ocean acidification, or new ways that species might interact. These threats require further study beyond the scope of this paper.

Protect key habitats, not just wilderness, to preserve species -- ScienceDaily

Some scientists have suggested we need to protect half of Earth's surface to preserve most of its species. A new Duke University-led study, however, cautions that it is the quality, not merely the quantity, of what we protect that matters.

"There's a lot of discussion about protecting 'Half Earth' as a minimum to protect biodiversity. The challenge is, which half do we protect?" said Stuart L. Pimm, Doris Duke Professor of Conservation Ecology at Duke's Nicholas School of the Environment, who was lead author of the new study.

"The predilection of national governments is to protect areas that are 'wild' -- that is, typically remote, cold, or arid," Pimm said. "Unfortunately, those areas often hold relatively few species. Our analysis shows that protecting even as much as half of the world's large wilderness areas will not protect many more species than at present."

To protect as many at-risk species as possible, especially those with small ranges, governments should expand their conservation focus and prioritize the protection of key habitats outside existing wildernesses, parks and preserves, Pimm and his coauthors from China and Brazil say.

"If we are to protect most species from extinction we have to protect the right places -- special places -- not just more area, per se," said Binbin Li, assistant professor of environmental sciences at Duke Kunshan University in China.

The team's new peer-reviewed study, published August 29 in *Science Advances*, uses geospatial analysis to map how well the world's current system of protected areas overlaps the ranges of nearly 20,000 species of mammals, birds and amphibians, the species that scientists know best.

"We found that global conservation efforts have enhanced protection for

many species -- for example, nearly half the species of birds with the smallest geographical ranges now have at least part of their ranges protected to a degree -- but critical gaps still exist," said Clinton Jenkins, of Brazil's Instituto de Pesquisas Ecológicas.

These gaps occur worldwide, including in biodiversity hotspots such as the northern Andes, the coastal forests of Brazil, and southwestern China, and they will continue to persist even if governments protect to up to half of the world's remaining wild areas, the study shows.

"Certainly, there are good reasons to protect large wild areas: they provide environmental services," Pimm said. "An obvious example is the Amazon, where the loss of the forest there might cause massive changes to the climate. But to save as much biodiversity as possible, we have to identify the species that remain poorly protected -- which this paper does -- and then pinpoint where they are, so we can effect practical conservation."

Many of the unprotected habitats are small parcels of land in areas where human impacts are already felt, disqualifying them for protection as wildernesses.

Pimm, Jenkins and Li lead a nonprofit organization called SavingSpecies that partners with local conservation groups in South America, Asia and other regions to protect such lands.

"The 'Half Earth' approach provides an inspiring vision to protect the world's species," Pimm said. "A preoccupation with concentrating on the total area protected is misleading, however. It's quality, not quantity that matters."

Story Source:

Materials provided by **Duke University**. *Note: Content may be edited for style and length.*

Teen dating violence is down, but boys still report more violence than girls, British Columbia study finds -- ScienceDaily

When it comes to teen dating violence, boys are more likely to report being the victim of violence -- being hit, slapped, or pushed -- than girls. That's the surprising finding of new research from the University of British Columbia and Simon Fraser University.

Overall, fewer teens are experiencing physical abuse from their dating partners, with five per cent of teens reporting dating violence in 2013, down from six per cent in 2003.

However, the researchers found 5.8 per cent of boys and 4.2 per cent of girls said they had experienced dating violence in the past year.

First author Catherine Shaffer, a PhD student from SFU who was involved in the study, says more research is needed to understand why boys are reporting more dating violence.

"It could be that it's still socially acceptable for girls to hit or slap boys in dating relationships," she said. "This has been found in studies of adolescents in other countries as well."

She added that the overall decline in dating violence, while small, is encouraging.

"Young people who experience dating violence are more likely to act out and take unnecessary risks, and they're also more likely to experience depression or think about or attempt suicide," Shaffer said. "That's why it's good to see that decline in dating violence over a 10-year span. It suggests that healthy relationship programs are making an impact among youth."

The study is the first in Canada to look at dating violence trends among

adolescents over time, and the first in North America to compare trends for boys and girls. Researchers analyzed data from three B.C. Adolescent Health Surveys involving 35,900 youth in grade 7 to 12 who were in dating relationships.

Elizabeth Saewyc, senior study author and UBC nursing professor, said the findings highlight the need for more support programs for both boys and girls in dating relationships.

"A lot of our interventions assume that the girl is always the victim, but these findings tell us that it isn't always so," said Saewyc. "And relationship violence, be it physical, sexual or other forms, and regardless who the perpetrator is, is never OK. Health-care providers, parents and caregivers, schools and others can protect teens from dating violence by helping them define what healthy relationships looks like, even before their first date."

The study analyzed surveys conducted by the McCreary Centre Society, a community-based organization dedicated to adolescent health research in B.C. Results were published recently in the *Journal of Interpersonal Violence*.

Story Source:

Materials provided by **University of British Columbia**. *Note: Content may be edited for style and length.*

China is hot spot of ground-level ozone pollution: New study: Ozone levels higher across China than in other countries tracking the air pollutant -- ScienceDaily

In China, people breathe air thick with the lung-damaging pollutant ozone two to six times more often than people in the United States, Europe, Japan, or South Korea, according to a new assessment. By one metric -- total number of days with daily maximum average ozone values (8-hour average) greater than 70 ppb -- China had twice as many high ozone days as Japan and South Korea, three times more than the United States, and six times more than Europe.

"We find that in the most populous urban regions of eastern and central China, there are more than 60 days in a calendar year with surface ozone levels exceeding the Chinese national ozone air quality standard," said Lin Zhang of Peking University, lead author of the study in the current issue of *Environmental Science & Technology Letters*.

"China has become a hot spot of present-day surface ozone pollution," said Owen Cooper, a co-author on the research paper and a CIRES scientist working in NOAA's Chemical Sciences Division. "Human and vegetation exposure in China is greater than in other developed regions of the world with comprehensive ozone monitoring."

Many countries regulate ozone because of the damage the pollutant does to plants and people.

In the United States, for example, the current health-based standard for ground-level ozone, set by the U.S. Environmental Protection Agency, is 70 ppb (based on the maximum daily 8-hour average). The Chinese national ozone air quality standard is a daily maximum 8-hour average greater than

160 micrograms per cubic meter, equivalent to about 80 ppb.

Ground level ozone is most commonly formed when volatile organic compounds and nitrogen oxides react in the atmosphere in the presence of sunlight. The burning of fossil fuels and biomass burning (from crop clearing or forest fires) are major sources of volatile organic compounds and nitrogen oxides. Since the 1990s, tighter controls on emissions of those ingredients have lessened ozone pollution in many European and U.S. cities. But the extent of surface ozone pollution in China hasn't been widely recognized, in part because there were so few Chinese monitoring sites before 2012, according to the researchers.

For this study, the researchers used data from a relatively new network of 1,600 ozone monitors in China and a massive new global ozone database to quantify ozone levels in China and compare those to the levels in other countries.

The new report shows that China has higher ozone pollution levels than all nations with ozone monitors, including the United States, Europe, Japan, and South Korea. Every ozone metric the researchers looked at rose continuously in China over the last five years. "We found the largest increases in ozone exposure in eastern and central China, especially in the most populous areas. These results indicate an increasing severity of human and crop/ecosystem ozone exposure across China," said Xiao Lu in Zhang's group, first author of the study.

In fact, present-day ozone levels in major Chinese cities are comparable to U.S. levels in the 1980s and 1990s. "Ozone levels in Beijing today are similar to Los Angeles in the 1990s, when emission controls were just beginning to have an impact on reducing ozone levels there," said Cooper.

WINTER VS. SUMMER CHALLENGES

For the past several years, wintertime haze pollution has been the main public concern in China and the focus of government action on air pollution, according to Zhang. The Chinese government has implemented stringent emission control measures to improve air quality: Since 2013, the Action Plan on Air Pollution Prevention and Control has reduced the concentration

of primary air pollutants and particulate matter an average of 35 percent for 74 major cities.

Zhang and Lu think the harmful effects of surface ozone pollution are much less recognized. "Many people in China do not realize that we may suffer severe ozone pollution under a typical blue sky in summer days. The emerging severity of ozone pollution in China now presents a new challenge for emission control strategies," Zhang said.

OZONE HARMS CROPS

Because ozone can harm plants, including crops, the researchers also investigated the potential for ozone-induced plant damage in China. One vegetation metric they examined captures accumulated ozone exposure exceeding a threshold above which tree growth or crop yield is expected to be reduced, over a crop's typical three-month growing season.

In China, values for that metric were 1.4 -- 2 times higher than in Japan, South Korea, Europe, and the United States. Studies done before 2010 at a few Chinese sites concluded that ozone pollution was already reducing wheat yields up to 6-15 percent. "And because ozone levels in China have increased since then, we would expect to see even greater crop loss now," said Cooper.

TROPOSPHERIC OZONE ASSESSMENT REPORT

The database the researchers used in this analysis is part of the Tropospheric Ozone Assessment Report (TOAR), a series of global assessments of ozone pollution and its relevance to people, plants, and climate. CIRES' Owen Cooper is chair of the research project's steering committee. "This is exactly the kind of follow-on assessment we hoped TOAR would inspire," he said.

According to lead author Zhang, scientists have known that there are high surface ozone levels in present-day China; what they didn't know was how China's ozone pollution compared with other industrialized countries in terms of magnitude, frequency, human, and vegetation exposure. "Our study presents such a novel comparison by combining the Chinese ozone data with the TOAR dataset," said Zhang.

How unsecured medical record systems and medical devices put patient lives at risk -- ScienceDaily

A team of physicians and computer scientists at the University of California has shown that it is easy to modify medical test results remotely by attacking the connection between hospital laboratory devices and medical record systems.

These types of attacks might be more likely used against high-profile targets, such as heads of state and celebrities, than against the general public. But they could also be used by a nation-state to cripple the United States' medical infrastructure.

The researchers from UC San Diego and UC Davis detailed their findings Aug. 9 at the Black Hat 2018 conference in Las Vegas, where they staged a demonstration of the attack. Dubbed Pestilence, the attack is solely proof-of-concept and will not be released to the general public. While the vulnerabilities the researchers exploited are not new, this is the first time that a research team has shown how they could be exploited to compromise patient health.

These vulnerabilities arise from the standards used to transfer patient data within hospital networks, known as the Health Level Seven standards, or HL7. Essentially the language that allows all devices and systems in a medical facility to communicate, HL7 was developed in the 1970s and has remained untouched by many of the cybersecurity advances made in the last four decades.

Implementation of the standards on aging medical equipment by personnel with little or no cybersecurity training has led to untold amounts of patient data circulating in an unsecure fashion. Specifically, the data are transmitted as unencrypted plain text on networks that do not require any passwords or

other forms of authentication.

Data hacking in hospitals has been in the news in recent years. But researchers want to draw attention to how that data, once compromised, could be manipulated. "Healthcare is distinct from other sectors in that the manipulation of critical infrastructure has the potential to directly impact human life, whether through direct manipulation of devices themselves or through the networks which connect them," the researchers write in a white paper released in conjunction with their Black Hat demonstration.

The vulnerabilities and methodologies used to create the Pestilence tool have been previously published. The innovation here is combining computer science know-how and clinicians' knowledge to exploit weaknesses in the HL7 standard to negatively impact the patient care process.

The team includes Dr. Christian Dameff, an emergency physician and clinical informatics fellow, and Maxwell Bland, a master's student in computer science, both at UC San Diego, and Dr. Jeffrey Tully, an anesthesiology resident at the UC Davis Medical Center. Physicians need to be able to trust that their data are accurate, Tully said. "As a physician, I aim to educate my colleagues that the implicit trust we place in the technologies and infrastructure we use to care for our patients may be misplaced, and that an awareness of and vigilance for these threat models is critical for the practice of medicine in the 21st century," he said.

Securing data against manipulation is imperative. "We are talking about this because we are trying to secure healthcare devices and infrastructure before medical systems experience a major failure," Dameff said. "We need to fix this now."

Researchers outline countermeasures medical systems can take to protect themselves against these types of attack.

The Pestilence tool

Researchers used what's called a "man in the middle attack," where a computer inserts itself between the laboratory machine and the medical records system. Bland, the UC San Diego computer science graduate student,

automated the attack so it could tackle large amounts of data remotely. Researchers did not infiltrate an existing hospital system, of course. Instead, they built a testbed comprising medical laboratory testing devices, computers and servers. This allowed the team to run tests, such as blood and urine analysis, intercept the test results, change them and then send the modified information to a medical records system.

Researchers took normal blood test results and modified them to make it look like the patient was suffering from diabetic ketoacidosis, or DKA, a severe complication of diabetes. This diagnosis would cause physicians to prescribe an insulin drip, which in a healthy patient could lead to a coma, or even death.

Researchers also modified normal blood test results to look like the patient had extremely low potassium. Treatment with a potassium IV on a healthy patient would cause a heart attack, which would likely be fatal.

Countermeasures

The researchers detail a number of steps that hospitals and government agencies can take to protect medical infrastructure in their Black Hat white paper.

Hospitals need to improve their security practices. Specifically, medical record systems and medical devices need to be password-protected and secured behind a firewall. Each device and system on the network needs to be restricted to communicating with only one server, to limit hackers' opportunities to penetrate inside hospital networks. This is called "network segmenting" and is the best way to protect medical infrastructure, said Bland, the computer science graduate student at the Jacobs School of Engineering at UC San Diego.

Researchers also would like to raise awareness of a new standard that could replace HL7: the Fast Healthcare Interoperability Resource, or FHIR, would allow for encrypted communications inside hospital networks.

Hospital IT staff need to be made aware of cybersecurity issues and trained to put in place defenses against potential attacks, researchers said. For example,

IT personnel need to know how to configure networks and servers to support encryption. Researchers point a 2017 report from a Health and Human Services task force stating that 80 percent of hospital IT personnel are not trained in cybersecurity.

In addition, cybersecurity needs to become part of the FDA approval process for healthcare devices, the researchers said. Manufacturers should be encouraged to adopt the newest and most secure operating systems. For example, today, many medical devices still run on Windows XP, an operating system that was released in 2001 and is no longer supported by Microsoft -- meaning that vulnerabilities are not fixed. These devices can't be easily upgraded as they would need to be taken offline, which would compromise patient care. In addition, some devices are too told to be upgraded.

"Working together, we are able to raise awareness of security vulnerabilities that have the potential to impact patient care and then develop solutions to remediate them," UC Davis' Tully said.

Celebrity culture likely contributed to destigmatizing out-of-wedlock childbirth -- ScienceDaily

In 1992, former Vice President Dan Quayle criticized the sitcom character Murphy Brown's decision to have a child out of wedlock. His comments soon expanded to include "the cultural elite in Hollywood," who were accused of undermining traditional family values.

Quayle's comments ignited discussions that dominated the day's news cycle and continue today about how celebrities might be contributing to the demise of the nuclear family, yet 40 years of data from one reputable celebrity news source suggests that celebrities in fact have fewer out-of-wedlock childbirths compared to the rest of the U.S. population.

But that's just part of the answer.

"Responding to the question of whether celebrities have more children out of wedlock depends on exactly who you're comparing them to," says Hanna Grol-Prokopczyk, an assistant professor in the University at Buffalo Department of Sociology and author of a new study that considers how media depictions of celebrity childbearing might contribute to destigmatizing having children outside of marriage.

Grol-Prokopczyk's study, published this month in the journal *Demographic Research*, analyses media presentations of celebrities' childbearing both qualitatively and quantitatively to understand how celebrity news might influence larger society.

Between 1940 and 2009, the number of U.S. births to unmarried women increased from about 4 percent to nearly 41 percent.

Most research trying to account for this increase has focused on economic

and cultural factors, but Grol-Prokopczyk wondered how celebrities might be affecting that 10-fold rise.

"No one has actually tested whether celebrities in fact engage in more out-of-wedlock childbearing than the general public," she says. "This is an important question to address because the power of celebrity culture to shape all kinds of decisions, including childbearing-related decisions, is often under-acknowledged."

Grol-Prokopczyk's interest in the possibility that celebrities might shape how we think about the nature of the family and the right environment in which to have children led her to test this idea.

With People magazine as her yardstick for reports of celebrity pregnancy, Grol-Prokopczyk analyzed each cover that showed a celebrity pregnancy or baby and coded that cover -- beginning with the debut issue in 1974 through the end of 2014 -- noting the parent's relationship status at the time of the pregnancy announcement and the time of the child's birth.

For Grol-Prokopczyk, People magazine served as a reliable source of data for exploring this issue.

First and most generally, celebrity news travels quickly and pervasively.

One national survey found that 74 percent of U.S. adults knew about Angelina Jolie's decision to have a preventative double mastectomy just weeks after her op-ed appeared in the New York Times in May of 2013.

Second, People magazine is one the most widely read magazines in the United States, and has for at least most of the last 10 years been the country's most popular weekly, reaching as many as 40 million readers with each issue.

People's website is also a heavily trafficked companion to its print edition with over 70 million unique monthly visitors.

And third, People has maintained over the course of its publication history a reputation for providing trustworthy coverage by avoiding fictional stories or reporting gossip as news.

Although Grol-Prokopczyk's findings suggest that celebrities have fewer babies out of wedlock than the full population, she says comparing those two groups might not be entirely fair.

"If you compare celebrities to just white Americans -- which could make sense given that until recently People magazine has disproportionally depicted white celebrity parents on its covers -- you find that celebrities have the same rates of non-marital fertility," she says.

The findings, however, curiously return to Quayle's comments from the early '90s when comparing white celebrities with non-celebrities who have at least some college education.

In this case, celebrities have had higher rates of non-marital childbearing.

"If you think about Dan Quayle's social milieu, he was probably most worried about the nuclear family being threatened among the white middle class. Quayle's remarks about Murphy Brown included his observation that the character 'epitomizes today's intelligent, highly paid, professional woman,'" says Grol-Prokopczyk.

And the findings indicate that celebrities were having more babies out of wedlock when compared to white women with college education.

Grol-Prokopczyk also found that most celebrities featured on People magazine's covers who got pregnant while unmarried did not marry before the child's birth. Since the mid-2000s, many have declared themselves, "engaged."

Instead of "shotgun weddings," Grol-Prokopczyk sees this as modeling what she calls "shotgun engagements," which if imitated in the general population could have contributed to a substantial rise of non-marital fertility in the U.S.

"Especially since the 2000s, when news about celebrity pregnancies became much more common, it seems very possible that celebrity culture has helped to destigmatize non-marital fertility, especially among white, middle-class women."

Diplomats' mystery illness linked to radiofrequency/microwave radiation, researcher says -- ScienceDaily

Her conclusions, she said, may aid in the treatment of the diplomats (and affected family members) and assist U.S. government agencies seeking to determine the precise cause. More broadly, Golomb said her research draws attention to a larger population of people who are affected by similar health problems.

"I looked at what's known about pulsed RF/MW in relation to diplomats' experiences," said Golomb. "Everything fits. The specifics of the varied sounds that the diplomats reported hearing during the apparent inciting episodes, such as chirping, ringing and buzzing, cohere in detail with known properties of so-called 'microwave hearing,' also known as the Frey effect.

"And the symptoms that emerged fit, including the dominance of sleep problems, headaches and cognitive issues, as well as the distinctive prominence of auditory symptoms. Even objective findings reported on brain imaging fit with what has been reported for persons affected by RF/MW radiation."

Beginning in 2016, personnel at the U.S. Embassy in Havana, Cuba (as well as Canadian diplomats and family members) described hearing strange sounds, followed by development of an array of symptoms. The source of the health problems has not been determined. Though some officials and media have described the events as "sonic attacks," some experts on sound have rejected this explanation. In May of this year, the State Department reported that U.S. government employees in Guangzhou, China had also experienced similar sounds and health problems.

Affected diplomats and family members from both locations were medically evacuated to the U.S. for treatment, but despite multiple government

investigations, an official explanation of events and subsequent illnesses has not been announced. At least two early published studies examining available data were inconclusive.

In her paper, scheduled to be published September 15 in *Neural Computation*, Golomb compared rates of described symptoms among diplomats with a published 2012 study of symptoms reported by people affected by electromagnetic radiation in Japan. By and large, she said the cited symptoms -- headache, cognitive problems, sleep issues, irritability, nervousness or anxiety, dizziness and tinnitus (ringing in the ears) -- occurred at strikingly similar rates.

Some diplomats reported hearing loss. That symptom was not assessed in both studies so rates could not be compared, but Golomb said it is widely reported in both conditions. She also noted that previous brain imaging research in persons affected by RF/ EMR "showed evidence of traumatic brain injury, paralleling reports in diplomats."

David O. Carpenter, MD, is director of the Institute for Health and the Environment at the University of Albany, part of the State University of New York. He was not involved in Golomb's study. He said evidence cited by Golomb illustrates "microwave hearing," which results "from heating induced in tissue, which causes 'waves' in the ear and results in clicks and other sounds." Reported symptoms, he said, characterize the syndrome of electrohypersensitivity (EHS), in which unusual exposure to radiofrequency radiation can trigger symptoms in vulnerable persons that may be permanent and disabling.

"We have seen this before when the Soviets irradiated the U.S. Embassy in Moscow in the days of the Cold War," he said.

Golomb, whose undergraduate degree was in physics, conducts research investigating the relationship of oxidative stress and mitochondrial function -- mechanisms shown to be involved with RF/EMR injury -- to health, aging, behavior and illness. Her work is wide-ranging, with published studies on Gulf War illness, statins, antibiotic toxicity, ALS, autism and the health effects of chocolate and trans fats, with a secondary interest in research methods, including placebos.

Golomb said an analysis of 100 studies examining whether low-level RF produced oxidative injury found that 93 studies concluded that it did. Oxidative injury or stress arises when there is an imbalance between the production of reactive oxygen species (free radicals) and the body's detoxifying antioxidant defenses. Oxidative stress has been linked to a range of diseases and conditions, from Alzheimer's disease, autism and depression to cancer and chronic fatigue syndrome, as well as toxic effects linked to certain drugs and chemicals. More to the point, Golomb said, oxidative injury has been linked to the symptoms and conditions reported in diplomats.

The health consequences of RF/MW exposure is a matter of on-going debate. Some government agencies, such as the National Institute of Environmental Health Sciences and the National Cancer Institute, publicly assert that low- to mid-frequency, non-ionizing radiation like those from microwaves and RF is generally harmless. They cite studies that have found no conclusive link between exposure and harm.

But others, including researchers like Golomb, dispute that conclusion, noting that many of the no-harm studies were funded by vested industries or had other conflicts of interest. She said independent studies over decades have reported biological effects and harms to health from nonionizing radiation, specifically RF/MW radiation, including via oxidative stress and downstream mechanisms, such as inflammation, autoimmune activation and mitochondrial injury.

Golomb compared the situation to persons with peanut allergies: Most people do not experience any adverse effect from peanut exposure, but for a vulnerable subgroup, exposure produces negative, even life-threatening, consequences.

In her analysis, Golomb concludes that "of hypotheses tendered to date, (RF/MW exposure) alone fits the facts, including the peculiar ones" regarding events in Cuba and China. She said her findings advocate for more robust attention to pulsed RF/MW and associated adverse health effects.

"The focus must be on research by parties free from ties to vested interests. Such research is needed not only to explain and address the symptoms in diplomats, but also for the benefit of the small fraction -- but large number --

of persons outside the diplomatic corps, who are beset by similar problems."

Disentangling the relationships between cultural traits and other variables: Researchers provide guidelines for differentiating between causation and mere correlation in cross-cultural studies -- ScienceDaily

A team of researchers led by scientists at the Max Planck Institute for the Science of Human History and Australian National University analyzed how to avoid misinterpreting correlations in cross-cultural studies, published in *Royal Society Open Science*. The researchers identify three sources of non-independence in cultural variables -- meaning, the variables are correlated but are not caused by each other -- and present methods to control for these.

Recently, a growing number of researchers are hoping to gain insights into human cultural evolution and the diversity of human culture using comparative studies. In essence, this type of work looks for cultural traits or environmental factors that cause other cultural traits -- such as the impact that subsistence strategy has on religious beliefs or the impact that the density of rivers has on language diversity. This work has been made vastly more approachable due to the expansion of large databases cataloging the relevant data, and the improvement of the programming and computing power necessary to make these comparisons. However, problems remain because many of the resulting studies make interpretations without controlling for factors that might make cultural variables seem causally related when they are not.

A team of researchers led by scientists at the Max Planck Institute for the Science of Human History and Australian National University has analyzed how to avoid misinterpreting correlations in cross-cultural studies and has identified three sources of non-independence in cultural variables -- meaning,

the variables are correlated, but are not caused by each other. The three sources identified are: (1) phylogenetic non-independence, meaning that the cultures are related to each other and a shared trait has been inherited by both from a common ancestor culture, rather than developed because it serves the same functional purpose in both cultures; (2) spatial autocorrelation, meaning the cultures share traits because they are geographically close to one another and thereby share many aspects of the same environment and history; and (3) covariation, meaning two traits correlate not because one causes the other but because both are caused or influenced by another variable.

The researchers then lay out guidelines to correct for these sources of non-independence and provide a case-study, looking at the connections between parasite load and various cultural and environmental factors. Parasite load has been hypothesized to have direct and dramatic impacts on a number of cultural traits -- including religiosity, sexual behavior, in-group preference and population density. However, by controlling for the three sources of non-independence described above, the authors show that, contrary to previous studies, parasites have no more explanatory power for cultural traits than many other environmental factors like biodiversity, climate and latitude.

The authors emphasize that there are two issues at play with these sources of non-independence. One is whether two variables are correlated in the first place. Correcting for phylogenetic non-independence and spatial autocorrelation addresses this issue. The second is whether the correlation between two variables is evidence of a causal relationship. Correcting for covariation addresses this issue. This is important, because simply finding a correlation between two variables and then hypothesizing a possible causal mechanism between them is not enough to prove causality. "For example, people have hypothesized that the correlation between a high parasite load and lower average IQ is caused by the metabolic costs of infection reducing investment in cognitive development," explains Simon Greenhill of the Max Planck Institute for the Science of Human History. "However, this hypothesis is highly problematic as IQ also correlates just as strongly with other measures of biodiversity, such as number of mammal species. But we are not tempted to come up with a hypothesis to explain why having lots of mammal species reduces a nation's average IQ."

"Our results suggest that we must be cautious in interpreting these cross-cultural correlations as a reflection of causal connections," states Greenhill. "Correcting for statistical biases is necessary to avoid being led astray by interpreting incidental associations as meaningful of causal connections."

Story Source:

Materials provided by **Max Planck Institute for the Science of Human History**. *Note: Content may be edited for style and length.*

Strange & Offbeat News

Quirky stories from all of ScienceDaily's health, technology, environment, and society sections.

- **State-of-the-art imaging techniques reveal heightened detail and beauty of vertebrate life** [周三, 05 9月 02:06]
  A mingling of science and art, the next-generation photographs of vertebrate skeletons are at once fascinating, eerie, intricate and exquisite.
- **A quantum gate between atoms and photons may help in scaling up quantum computers** [周二, 04 9月 23:47]
  The quantum computers of the future will be able to perform computations that cannot be done on today's computers. These may likely include the ability to crack the encryption that is currently used for secure electronic transactions, as well as the means to efficiently solve unwieldy problems in which the number of possible solutions increases exponentially.
- **Quantum weirdness in 'chicken or egg' paradox** [周二, 04 9月 23:47]
  The 'chicken or egg' paradox was first proposed by philosophers in Ancient Greece to describe the problem of determining cause-and-effect. Now, a team of physicists has shown that, as far as quantum physics is concerned, the chicken and the egg can both come first.
- **Artificial cells are tiny bacteria fighters** [周二, 04 9月 21:37]
  Newly created artificial cells can kill bacteria.
- **Little star sheds light on young planets** [周一, 03 9月 22:17]
  Astronomers discovered a dense disk of material around a young star, which may be a precursor to a planetary system. Their research could vastly improve models of how solar systems form, which would tell us more about our own place in the cosmos.
- **Sound can be used to print droplets that couldn't be printed before** [周六, 01 9月 03:01]
  Researchers have developed a new printing technology that uses sound waves to control the size of liquid droplets independent of fluid viscosity. This approach could greatly broaden the types of liquids, including biopharmaceuticals, that can be printed drop-on-demand. The researchers used sound waves to generate a highly confined force at the tip of the printer nozzle, which pulls the droplet. The higher the amplitude of the sound waves, the smaller the droplet size.
- **Better silicone adhesion Inspired by beetle feet** [周五, 31 8月 23:04]

A research team has succeeded in boosting the adhesive effect of a silicone material significantly inspired by the structure of beetle feet. In addition, they found out that the adhesiveness of the structured material changes drastically, if it is bent to varying degrees. Their results could be interesting for the development of tiny robots and gripping devices.

- **Are vulnerable lions eating endangered zebras?** [周五, 31 8月 23:04]
  Are Laikipia's recovering lions turning to endangered Grevy's zebras (Equus grevyi) for their next meal?

- **Synthetic microbiome? Genetic engineering allows different species of bacteria to communicate** [周五, 31 8月 21:09]
  What if the bacteria that live in your gut could monitor your health, report disease, and produce beneficial molecules? Researchers have gotten one step closer to creating such a 'synthetic microbiome' by engineering different species of bacteria so they can talk to each other. Given that there are over 1,000 different strains of intestinal interlopers in the human gut, such coordination is crucial for the development of systems that can sense and improve human digestive health.

- **Water worlds could support life, study says** [周五, 31 8月 20:35]
  The conditions for life surviving on planets entirely covered in water are more fluid than previously thought, opening up the possibility that water worlds could be habitable, according to a new article.

- **Robotic herding of a flock of birds using drones** [周四, 30 8月 21:53]
  Researchers made a new algorithm for enabling a single robotic unmanned aerial vehicle to herd a flock of birds away from a designated airspace. This novel approach allows a single autonomous quadrotor drone to herd an entire flock of birds away without breaking their formation.

- **Mongrel Mob gang opens up to New Zealand researchers for the good of their health** [周四, 30 8月 21:12]
  A gang known as the Mongrel Mob has opened up to New Zealand researchers, who have assessed the hepatitis prevalence, knowledge, and liver health risk factors of 52 gang members, affiliates and extended family.

- **How a NASA scientist looks in the depths of the great red spot to find water on Jupiter** [周四, 30 8月 03:38]
  One critical question has bedeviled astronomers for generations: Is there water deep in Jupiter's atmosphere, and if so, how much?

- **New Zealand penguins make mammoth migrations, traveling thousands of kilometers to feed** [周四, 30 8月 02:38]
  Fiordland penguins, Eudyptes pachyrhynchus, known as Tawaki, migrate up to 2,500 km from their breeding site, according to a new study.

- **Switching to hunter-gatherer lifestyle may increase diversity in children's gut microbes** [周四, 30 8月 01:34]
  Immersing city dwellers in the traditional lifestyle and diet of a rainforest village for two weeks increases the diversity of the visiting children's -- but not the adults' -- gut microbiota. In a small pilot study, researchers show that the immersion visit did little to shift the adults' skin, oral, nasal and fecal microbiota.

- **Mammal forerunner that reproduced like a reptile sheds light on brain evolution** [周四, 30 8月 01:34]
  Compared with the rest of the animal kingdom, mammals have the biggest brains and produce some of the smallest litters of offspring. A newly described fossil of an extinct mammal relative -- and her 38 babies -- is among the best evidence that a key development in the evolution of mammals was trading brood power for brain power.

- **Unstoppable monster in the early universe** [周四, 30 8月 01:32]
  Astronomers obtained the most detailed anatomy chart of a monster galaxy located 12.4 billion light-years away. Using the Atacama Large Millimeter/submillimeter Array (ALMA), the team revealed that the molecular clouds in the galaxy are highly unstable, which leads to runaway star formation.

- **Diplomats' mystery illness linked to radiofrequency/microwave radiation, researcher says** [周三, 29 8月 23:54]
  In a new article, a researcher makes the case that publicly reported symptoms and experiences of a 'mystery illness' afflicting American and Canadian diplomats in Cuba and China strongly match known effects of pulsed radiofrequency/microwave electromagnetic (RF/MW) radiation.

- **Goats prefer happy people** [周三, 29 8月 08:49]
  Goats can differentiate between human facial expressions and prefer to interact with happy people, according to a new study.

State-of-the-art imaging techniques reveal heightened detail and beauty of vertebrate life -- ScienceDaily

A mingling of science and art, the next-generation photographs of vertebrate skeletons are at once fascinating, eerie, intricate and exquisite.

"People are inherently interested in how these skeletons look," said W. Leo Smith, associate professor of ecology and evolutionary biology and associate curator at the University of Kansas Biodiversity Institute & Natural History Museum. "In any given scholarly paper, you'd be lucky to have a couple of hundred people read it top to bottom -- but a lot more people will look at the images. The more we can improve that, the more people you can get interested in your research."

Since the 1800s, biologists and paleontologists have taken pictures of specimens to perform comparative anatomical studies. Now, techniques pioneered by Smith and a team of researchers headquartered at KU are giving scientists around the world fresh methods to capture images of vertebrates -- a breakthrough enabling better, more useful digital pictures of Earth's biodiversity.

The team describes the two novel imaging procedures in a new paper appearing in the peer-reviewed journal *Copeia*.

One new process involves "cleared and stained" specimens, which have been stripped of their muscles in a time-honored technique using cow enzymes. The team discovered how to position such specimens within a glycerine-gelatin mixture for otherwise impossible images.

"The problem we had was we couldn't pose these animals because we've digested away all of the muscles," Smith said. "They're flaccid and useless, like a pile of clothes that fold in every direction. We wanted the ability to

pose them."

The researchers hunted for the best ratio of glycerine and gelatin that allowed specimens to be posed in a nondestructive medium that could be simply washed off after photography. Much of the "nitty gritty" work was performed by doctoral student Matthew Girard and intern Chesney A. Buck, an aspiring taxidermist interning with Smith's group from Van Go Inc., an arts-based employment program for at-risk teens and young adults.

"She was interested in artistic taxidermy, mixing animal parts like have been done with the jackalope," Smith said. "She knew about clearing and staining and wanted to know how to do it. After her internship, she volunteered for a year more. There was a lot of trial and error. We tried lots of different things."

Other co-authors on the new paper are Gregory S. Ornay, Rene P. Martin and Girard of KU's Biodiversity Institute, along with Matthew P. Davis and Sarah Z. Gibson of St. Cloud State University.

Eventually, the team found a 40 percent glycerine mixture that held specimens well and was sufficiently translucent for photography, allowing them new looks at specimens that could "float" within the matrix.

"You can see through this medium and give the specimen structure," Smith said. "Now you can get a photo of a fish specimen head on and look at it from all these different angles. There's something different about being able to see anatomical structure in new ways that really does help analysis. Before, we struggled with how to pose these things. For instance, fish are famous for having two sets of jaws, an oral set like ours and then another set of teeth where our voice box is -- you couldn't get a photo of these teeth head-on before now."

Smith said the new technique could be used on a host of vertebrate species beyond the fishes he studies.

"It'd be great to pose a snake coiled, but before now they just wouldn't hold in that pose. Or if you were trying to get an image of some structure obscured by the wing of a bird and couldn't get it out of the way, we've often had to cut

the wing off, but now you could deflect the wing to show that structure."

A second method developed by the group employs fluorescent microscopy to examine specimens and create captivating images of alizarin-stained recent and fossil vertebrates. The work hinges on the fact that alizarin, a stain long used in the clearing and staining process to identify bones in a specimen, fluoresces when exposed to the right wavelengths of light -- a phenomenon Smith discovered himself. (Another team independently discovered the phenomenon in a paper about zebrafish.)

"Alizarin red is used to dye a specimen's bones, and it fluoresces like a Grateful Dead poster," Smith said. "We use lights that have high energy and look for reflections of re-emitted fluorescent wavelength, and the microscope has filters that block all the other light. The skin and everything else disappears because it doesn't fluoresce -- it's a fast way to clear out all the extra stuff and is incredibly useful when you're trying to see where bones are connected. It was pure luck to find this."

The KU researcher reported the fluorescence microscopy finding to colleagues last year at the annual meeting of the American Society of Ichthyologists and Herpetologists, and today other investigators in the field already are using the matrix in their own digital imaging work thanks to the presentation.

"Now lots of people are doing it," Smith said. "It's been really rewarding. You feel like you contributed something to make this kind of research more interesting and allow us to study anatomy better."

While Smith doesn't consider the how-to descriptions of new imaging techniques to be of equal weight as the scientific papers he regularly produces, he stressed the importance of providing compelling images to conveying information to fellow investigators and the public alike.

"At end of the day, the picture is worth a thousand words," he said. "Images allow you to fundamentally share how things work and improve your ability to tell someone else about your novel discoveries."

https://www.sciencedaily.com/releases/2018/09/180904140605.htm

A quantum gate between atoms and photons may help in scaling up quantum computers -- ScienceDaily

The quantum computers of the future will be able to perform computations that cannot be done on today's computers. These may likely include the ability to crack the encryption that is currently used for secure electronic transactions, as well as the means to efficiently solve unwieldy problems in which the number of possible solutions increases exponentially. Research in the quantum optics lab of Prof. Barak Dayan in the Weizmann Institute of Science may be bringing the development of such computers one step closer by providing the "quantum gates" that are required for communication within and between such quantum computers.

In contrast with today's electronic bits that can only exist in one of two states -- zero or one -- quantum bits known as qubits can also be in states that correspond to both zero and one at the same time. This is called quantum superposition, and it gives qubits an edge as a computer made of them could perform numerous computations in parallel.

There is just one catch: The state of quantum superposition state can exist only as long as it is not observed or measured in any way by the outside world; otherwise all the possible states collapse into a single one. This leads to contradicting requirements: For the qubits to exist in several states at once they need to be well isolated, yet at the same time they need to interact and communicate with many other qubits. That is why, although several labs and companies around the world have already demonstrated small-scale quantum computers with a few dozen qubits, the challenge of scaling up these to the desired scale of millions of qubits remains a major scientific and technological hurdle.

One promising solution is using isolated modules with small, manageable numbers of qubits, which can communicate between them when needed with

optical links. The information stored in a material qubit (e.g. a single atom or ion) would then be transferred to a "flying qubit" -- a single particle of light called a photon. This photon can be sent through optical fibers to a distant material qubit and transfer its information without letting the environment sense the nature of that information. The challenge in creating such a system is that single photons carry extremely small amounts of energy, and the minuscule systems comprising material qubits generally do not interact strongly with such weak light.

Dayan's quantum optics lab in the Weizmann Institute of Science is one of the few groups worldwide that are focused entirely on attacking this scientific challenge. Their experimental setup has single atoms coupled to unique micron-scale silica resonators on chips; and photons are sent directly to these through special optical fibers. In previous experiments Dayan and his group had demonstrated the ability of their system to function as a single-photon activated switch, and also a way to "pluck" a single photon from a flash of light. In the present study, reported in *Nature Physics*, Dayan and his team succeeded -- for the first time -- to create a logic gate in which a photon and an atom automatically exchange the information they carry.

"The photon carries one qubit, and the atom is a second qubit," says Dayan. "Each time the photon and the atom meet they exchange the qubits between them automatically and simultaneously, and the photon then continues on its way with the new bit of information. In quantum mechanics, in which information cannot be copied or erased, this swapping of information is in fact the basic unit of reading and writing -- the "native" gate of quantum communication."

This type of logic gate -- a SWAP gate -- can be used to exchange qubits both within and between quantum computers. As this gate needs no external control fields or management system, it can enable the construction of the quantum equivalent of very large-scale integration (VLSI) networks. "The SWAP gate we demonstrated is applicable to photonic communication between all types of matter-based qubits -- not only atoms," says Dayan. "We therefore believe that it will become an essential building-block in the next generation of quantum computing systems."

Story Source:

Quantum weirdness in 'chicken or egg' paradox -- ScienceDaily

The "chicken or egg" paradox was first proposed by philosophers in Ancient Greece to describe the problem of determining cause-and-effect.

Now, a team of physicists from The University of Queensland and the NÉEL Institute has shown that, as far as quantum physics is concerned, the chicken and the egg can both come first.

Dr Jacqui Romero from the ARC Centre of Excellence for Engineered Quantum Systems said that in quantum physics, cause-and-effect is not always as straightforward as one event causing another.

"The weirdness of quantum mechanics means that events can happen without a set order," she said.

"Take the example of your daily trip to work, where you travel partly by bus and partly by train.

"Normally, you would take the bus then the train, or the other way round.

"In our experiment, both of these events can happen first," Dr Romero said.

"This is called `indefinite causal order' and it isn't something that we can observe in our everyday life."

To observe this effect in the lab, the researchers used a setup called a photonic quantum switch.

UQ's Dr Fabio Costa said that with this device the order of events -- transformations on the shape of light -- depends on polarisation.

"By measuring the polarisation of the photons at the output of the quantum switch, we were able to show the order of transformations on the shape of

light was not set."

"This is just a first proof of principle, but on a larger scale indefinite causal order can have real practical applications, like making computers more efficient or improving communication."

The research was published in *Physical Reviews Letters* by the American Physical Society.

Story Source:

Materials provided by **University of Queensland**. *Note: Content may be edited for style and length.*

Artificial cells are tiny bacteria fighters -- ScienceDaily

"Lego block" artificial cells that can kill bacteria have been created by researchers at the University of California, Davis Department of Biomedical Engineering. The work is reported Aug. 29 in the journal *ACS Applied Materials and Interfaces*.

"We engineered artificial cells from the bottom-up -- like Lego blocks -- to destroy bacteria," said Assistant Professor Cheemeng Tan, who led the work. The cells are built from liposomes, or bubbles with a cell-like lipid membrane, and purified cellular components including proteins, DNA and metabolites.

"We demonstrated that artificial cells can sense, react and interact with bacteria, as well as function as systems that both detect and kill bacteria with little dependence on their environment," Tan said.

The team's artificial cells mimic the essential features of live cells, but are short-lived and cannot divide to reproduce themselves. The cells were designed to respond to a unique chemical signature on E. coli bacteria. They were able to detect, attack and destroy the bacteria in laboratory experiments.

Artificial cells previously only had been successful in nutrient-rich environments, Tan said. However, by optimizing the artificial cells' membranes, cytosol and genetic circuits, the team made them work in a wide variety of environments with very limited resources such as water, emphasizing their robustness in less-than-ideal or changing conditions. These improvements significantly broaden the overall potential application of artificial cells.

Antibacterial artificial cells might one day be infused into patients to tackle infections resistant to other treatments. They might also be used to deliver drugs at the specific location and time, or as biosensors.

Coauthors on the paper are Yunfeng Ding, Eliza Morris, Luis Contreras-Llano and Michelle Mao. The work was supported by NSF, a Branco-Weiss Fellowship to Tan and by a UC MEXUS-CONACYT Doctoral Fellowship to Contreras-Llano.

Story Source:

Materials provided by **University of California - Davis**. *Note: Content may be edited for style and length.*

Little star sheds light on young planets: Astronomers discover new stage in evolution of young solar systems -- ScienceDaily

Early in 2017, Assistant Professor Yoko Oya gave graduate student Yuki Okoda some recent complex data on a nearby star with which she could begin her Ph.D. Little did she realize that what she would find could unlock not only the secrets of how planets form but possibly her career as a professional astronomer.

The star in question (only known by its catalog number IRAS 15398-3359) is small, young and relatively cool for a star. It's diminutive stature means the weak light it shines can't even reach us through a cloud of gas and dust that surrounds it. But this doesn't stop inquisitive minds from exploring the unknown.

In 2013, Oya and her collaborators used the Atacama Large Millimeter/submillimeter Array (ALMA) in Chile to observe the star in submillimeter wavelengths, as that kind of light can penetrate the dust cloud -- for reference, red light is around 700 nanometers. A painstaking analysis revealed some interesting nebulous structures, despite the images they worked from being difficult to comprehend.

"The greatest academic challenge I've faced was trying to make sense of grainy images. It's extremely difficult to know exactly what you're really looking at." says Okoda. "But I felt compelled to explore the nature of the structures Dr. Oya had seen with ALMA, so I came up with a model to explain them." The model she produced came as a surprise to Okoda and her colleagues, but it fit the data perfectly. It describes a dense disk of material that consists of gas and dust from the cloud that surrounds the star. This has never before been seen around such a young star.

The disk is a precursor to a protoplanetary disk, which is far denser still and eventually becomes a planetary system in orbit around a star.

"We can't say for sure this particular disk will coalesce into a new planetary system," explains Oya. "The dust cloud may be pushed away by stellar winds or it might all fall into the star itself, feeding it in the process. What's exciting is how quickly this might happen."

The star is small at around 0.7 percent the mass of our sun, based on observations of the mass of the surrounding cloud. It could grow to as large as 20 percent in just a few tens of thousands of years, a blink of the eye on the cosmic scale.

"I hope our observations and models will enhance knowledge of how solar systems form," says Okoda. "My research interests involve young protostellar objects, and the implication that protoplanetary disks could form earlier than expected really excites me."

Okoda began this project a year-and-a-half ago to hone her skills as an astronomer, but mirroring the young star she observed, the practice evolved quickly and became a full research project, which will hopefully earn her a Ph.D. from the University of Tokyo.

The observations and resultant model were only possible thanks to advancements in radio astronomy with observatories such as ALMA. The team was lucky that the plane of the disk is level with our own solar system as this means the starlight ALMA sees passes through enough of the gas and dust to divulge important characteristics of it.

"We were also lucky to be given time with ALMA to carry out our observations. Only about 20 percent of applications actually go ahead," explains Oya. "With highly specialized astronomical instruments, there is much competition for time. My hope is our success will inspire a new generation of astronomers in Japan to reach for the stars."

Story Source:

Materials provided by **University of Tokyo**. *Note: Content may be edited for*

style and length.

Sound can be used to print droplets that couldn't be printed before -- ScienceDaily

Harvard University researchers have developed a new printing method that uses sound waves to generate droplets from liquids with an unprecedented range of composition and viscosity. This technique could finally enable the manufacturing of many new biopharmaceuticals, cosmetics, and food and expand the possibilities of optical and conductive materials.

"By harnessing acoustic forces, we have created a new technology that enables myriad materials to be printed in a drop-on-demand manner," said Jennifer Lewis, the Hansjorg Wyss Professor of Biologically Inspired Engineering at the Harvard John A. Paulson School of Engineering and Applied Sciences and the senior author of the paper.

Lewis is also a Core Faculty Member at the Wyss Institute for Biologically Inspired Engineering and the Jianming Yu Professor of Arts and Sciences at Harvard.

The research is published in *Science Advances*.

Liquid droplets are used in many applications from printing ink on paper to creating microcapsules for drug delivery. Inkjet printing is the most common technique used to pattern liquid droplets, but it's only suitable for liquids that are roughly 10 times more viscous than water. Yet many fluids of interest to researchers are far more viscous. For example, biopolymer and cell-laden solutions, which are vital for biopharmaceuticals and bioprinting, are at least 100 times more viscous than water. Some sugar-based biopolymers could be as viscous as honey, which is 25,000 times more viscous than water.

The viscosity of these fluids also changes dramatically with temperature and composition, makes it even more difficult to optimize printing parameters to control droplet sizes.

"Our goal was to take viscosity out of the picture by developing a printing system that is independent from the material properties of the fluid," said Daniele Foresti, first author of the paper, the Branco Weiss Fellow and Research Associate in Materials Science and Mechanical Engineering at SEAS and the Wyss Institute.

To do that, the researchers turned to acoustic waves.

Thanks to gravity, any liquid can drip -- from water dripping out of a faucet to the century-long pitch drop experiment. With gravity alone, droplet size remains large and drop rate difficult to control. Pitch, which has a viscosity roughly 200 billion times that of water, forms a single drop per decade.

To enhance drop formation, the research team relies on generating sound waves. These pressure waves have been typically used to defy gravity, as in the case of acoustic levitation. Now, the researchers are using them to assist gravity, dubbing this new technique acoustophoretic printing.

The researchers built a subwavelength acoustic resonator that can generate a highly confined acoustic field resulting in a pulling force exceeding 100 times the normal gravitation forces (1 G) at the tip of the printer nozzle -- that's more than four times the gravitational force on the surface of the sun.

This controllable force pulls each droplet off of the nozzle when it reaches a specific size and ejects it towards the printing target. The higher the amplitude of the sound waves, the smaller the droplet size, irrespective of the viscosity of the fluid.

"The idea is to generate an acoustic field that literally detaches tiny droplets from the nozzle, much like picking apples from a tree," said Foresti.

The researchers tested the process on a wide range of materials from honey to stem-cell inks, biopolymers, optical resins and, even, liquid metals. Importantly, sound waves don't travel through the droplet, making the method safe to use even with sensitive biological cargo, such as living cells or proteins.

"Our technology should have an immediate impact on the pharmaceutical

industry," said Lewis. "However, we believe that this will become an important platform for multiple industries."

"This is an exquisite and impactful example of the breadth and reach of collaborative research," said Dan Finotello, director of NSF's MRSEC program. "The authors have developed a new printing platform using acoustic-forces, which, unlike in other methods, are material-independent and thus offer tremendous printing versatility. The application space is limitless."

The Harvard Office of Technology Development has protected the intellectual property relating to this project and is exploring commercialization opportunities.

This research was co-authored by Katharina Kroll, Robert Amissah, Francesco Sillani, Kimberly Homan and Dimos Poulikakos. It was funded by Society in Science through the Branco Weiss Fellowship and the National Science Foundation through Harvard MRSEC.

Video: https://www.youtube.com/watch?v=FCbxfe9F6fs

Better silicone adhesion Inspired by beetle feet -- ScienceDaily

Geckos, spiders and beetles have shown us how to do it: thanks to special adhesive elements on their feet, they can easily run along ceilings or walls. The science of bionics tries to imitate and control such biological functions, for technological applications and the creation of artificial materials. A research team from Kiel University (CAU) has now succeeded in boosting the adhesive effect of a silicone material significantly. To do so they combined two methods: First, they structured the surface on the micro scale based on the example of beetle feet, and thereafter treated it with plasma. In addition, they found out that the adhesiveness of the structured material changes drastically, if it is bent to varying degrees. Among other areas of application, their results could be interesting for the development of tiny robots and gripping devices. They have been published in the latest editions of the scientific journals *Advanced Materials* and *ACS Applied Materials & Interfaces*.

Elastic synthetic materials such as silicone elastomers are very popular in industry. They are flexible, re-usable, cheap and easy to produce. They are therefore used for example as seals, for insulation or as corrosion protection. However, due to their low surface energy, they are hardly adhesive at all. This makes it difficult, for example, to paint silicone surfaces.

Surfaces with a mushroom-like microstructure adhere much better

Professor Stanislav N. Gorb and Emre Kizilkan from the Functional Morphology and Biomechanics working group are researching how to improve the adhesive properties of silicone elastomers. Their example to mimic is the surface structure of certain male leaf beetles (Chrysomelidae), looking like mushrooms. In two recent studies, they discovered that silicone elastomers adhere best if their surface is modified into mushroom-like structures and thereafter specifically treated with plasma. The electrically-charged gas which is the fourth state of matter, alongside solids, liquids and

gases. Thus, the researchers combined a geometrical and a chemical method, to imitate biology. In addition, they showed that the degree of curvature of the materials affects their adhesion.

"Animals and plants provide us with a wealth of experience about some incredible features. We want to transfer the mechanisms behind them to artificial materials, to be able to control their behaviour in a targeted manner," said the zoologist Gorb. Their goal of a reversible adhesion in the micro range without traditional glue could make completely new application possibilities conceivable -- for example in micro-electronics.

During experimental tests silicones are curved

In a first step, the research team compared silicone elastomers of three different surfaces: one unstructured, one with pillar-shaped elements and a third with a mushroom-like structure. Using a micro-manipulator, they stuck a glass ball onto the surfaces and then removed it again. They tested how the adhesion changes when the materials with microstructured surfaces are bent convex (inwards) and concave (outwards). "In this way, we were able to demonstrate that silicone materials with a mushroom-like structure and curved concave have the double range of adhesive strength," said doctoral researcher Emre Kizilkan, first author of the study. "With this surface structure, we can vary and control the adhesion of materials the most."

Exact parameters for material-friendly plasma treatment

In a second step, the scientists treated the silicone elastomers with plasmas. This method is normally used to functionalise plastic materials, in order to increase their surface energy and to improve their adhesive properties. In comparison with other methods using liquids, plasma treatments can promise greater longevity -- however, they often damage the surfaces of materials.

To find out how plasma treatments can significantly improve the adhesion of a material without damaging it, the scientists varied different parameters, such as the duration or the pressure. They found that the adhesion of unstructured surfaces on a glass substrate increased by approximately 30% after plasma treatment. On the mushroom-like structured surface the adhesion even increased by up to 91%. "These findings particularly surprised us,

because the structured surface is only half as large as the unstructured, but adhesion enhancement was even three times better after the plasma treatment," explained Kizilkan.

What happens when the treated and non-treated structured surfaces are removed from the glass substrate show the recordings with a high-speed camera: Because of its higher surface energy the plasma-treated microstructure remains fully in contact with the surface of the glass for 50,6 seconds. However, the contact area of the untreated microstructure is reduced quickly by around one third during the removal process, which is why the microstructure completely detaches from the glass substrate after 33 seconds already (Figure 3).

Especially suitable for applications in microelectronics

"We therefore have on a very small area an extremely strong adhesion with a wide range," summarizes the material scientist Kizilkan. This makes the results especially interesting for small-scale applications such as micro-robots. The findings of the Kiel working group have already resulted in the development of an extremely strong adhesive tape, which functions according to the "gecko principle," and can be removed without leaving any residue.

Story Source:

Materials provided by **Kiel University**. *Note: Content may be edited for style and length.*

Are vulnerable lions eating endangered zebras? New study looks at whether a recovering predator is causing another species to decline -- ScienceDaily

That's what a team of researchers led by WCS and WWF set out to discover -- whether the comeback of a top predator -- in this case lions in Laikipa County, Kenya -- were recovering at the expense of Grevy's zebras, which number only around 2,680 individuals with half of those living in Likipia.

In recent years, lion numbers have slowly recovered in this region as livestock ranching -- which commonly practiced shooting or poisoning lions -- has given way to wildlife tourism. Lions (*Panthera leo*) are classified as Threatened by IUCN.

Publishing their results in the journal *PLOS ONE*, the team used satellite telemetry to track the movements of both lions and zebras.

The team found that lions preyed on both Grevy's and plains zebras (*Equus quagga*) far less than expected. Their data showed that the population of Grevy's zebra populations may in fact be stabilizing with recruitment into the population tripling since 2004.

The researchers did conclude that competitive displacement by livestock and interference competition for grass from plains zebras, which are 22 times more abundant than Grevy's, are most likely the predominant threat to Grevy's zebras' recovery.

Story Source:

Materials provided by **Wildlife Conservation Society**. *Note: Content may be edited for style and length.*

Synthetic microbiome? Genetic engineering allows different species of bacteria to communicate -- ScienceDaily

More than 1,000 species of bacteria have been identified in the human gut, and understanding this incredibly diverse "microbiome" that can greatly impact health and disease is a hot topic in scientific research. Because bacteria are routinely genetically engineered in science labs, there is great excitement about the possibility of tweaking the genes of our intestinal interlopers so that they can do more than just help digest our food (e.g., record information about the state of the gut in real-time, report the presence of disease, etc.). However, little is known about how all those different strains communicate with each other, and whether it is even possible to create the kinds of signaling pathways that would allow information to be passed between them.

Now, researchers from the Wyss Institute at Harvard University, Harvard Medical School (HMS), and Brigham and Women's Hospital have successfully engineered a genetic signal-transmission system in which a molecular signal sent by Salmonella Typhimurium bacteria in response to an environmental cue can be received and recorded by *E. coli* in the gut of a mouse, bringing scientists a step closer to developing a "synthetic microbiome" composed of bacteria that are programmed to perform specific functions. The study is reported in *ACS Synthetic Biology*.

"In order to improve human health through engineered gut bacteria, we need to start figuring out how to make the bacteria communicate," said Suhyun Kim, a graduate student in the lab of Pamela Silver at the Wyss Institute and HMS, who is the first author of the paper. "We want to make sure that, as engineered probiotics develop, we have a means to coordinate and control them in harmony."

The team harnessed an ability that naturally occurs in some strains of bacteria

called "quorum sensing," in which the bacteria send and receive signal molecules that indicate the overall density of the bacterial colony and regulate the expression of many genes involved in group activities. A particular type of quorum sensing known as acyl-homoserine lactone (acyl-HSL) sensing has not yet been observed in the mammalian gut, so the team decided to see if they could repurpose its signaling system to create a bacterial information transfer system using genetic engineering.

The researchers introduced two new genetic circuits into different colonies of a strain of *E. coli* bacteria: a "signaler" circuit, and a "responder" circuit. The signaler circuit contains a single copy of a gene called luxI that is turned on by the molecule anhydrotetracycline (ATC) and produces a quorum-sensing signaling molecule. The responder circuit is structured such that when the signaling molecule binds to it, a gene called cro is activated to produce the protein Cro, which then turns on a "memory element" within the responder circuit. The memory element expresses two additional genes: LacZ and another copy of cro. The expression of LacZ causes the bacterium to turn blue if plated on a special agar, thus producing visual confirmation that the signal molecule has been received. The extra copy of cro forms a positive feedback loop that keeps the memory element on, ensuring that the bacterium continues to express LacZ over an extended period of time.

The researchers confirmed that this system works in vitro in both *E. coli* and *S. Typhimurium* bacteria, observing that the responder bacteria turned blue when ATC was added to the signaler bacteria. To see if it would work in vivo, they administered both signaler and responder *E. coli* bacteria to mice, and then gave the mice ATC in their drinking water for two days. When fecal samples from the mice were analyzed, over half of the mice displayed clear signs of 3OC6HSL signal transmission that persisted after two days on ATC.

"It was exciting and promising that our system, with single copy-based circuits, can create functional communication in the mouse gut," explained Kim. "Traditional genetic engineering introduces multiple copies of a gene of interest into the bacterial genome via plasmids, which places a high metabolic burden on the engineered bacteria and causes them to be easily outcompeted by other bacteria in the host."

Finally, the team repeated the in vivo experiment, but gave the mice signaler

S. Typhimurium bacteria and *E. coli* responder bacteria, to see if the signal could be transmitted across different species of bacteria within the mouse's gut. All mice displayed signs of signal transmission, confirming that the engineered circuits allowed communication between different species of bacteria in the complex environment of the mammalian gut.

The researchers hope to continue this line of inquiry by engineering more species of bacteria so that they can communicate, and by searching for and developing other signaling molecules that can be used to transmit information between them.

"Ultimately, we aim to create a synthetic microbiome with completely or mostly engineered bacteria species in our gut, each of which has a specialized function (e.g., detecting and curing disease, creating beneficial molecules, improving digestion, etc.) but also communicates with the others to ensure that they are all balanced for optimal human health," said corresponding author Silver, Ph.D., a Founding Core Faculty member of the Wyss Institute who is also the Elliot T. and Onie H. Adams Professor of Biochemistry and Systems Biology at HMS.

"The microbiome is the next frontier in medicine as well as wellness. Devising new technologies to engineer intestinal microbes for the better while appreciating that they function as part of a complex community, as was done here, represents a major step forward in this direction," said Wyss Founding Director Donald Ingber, M.D., Ph.D., who is also the Judah Folkman Professor of Vascular Biology at HMS and the Vascular Biology Program at Boston Children's Hospital, as well as Professor of Bioengineering at SEAS.

Water worlds could support life, study says: Scientists challenges idea that life requires 'Earth clone' -- ScienceDaily

The conditions for life surviving on planets entirely covered in water are more fluid than previously thought, opening up the possibility that water worlds could be habitable, according to a new paper from the University of Chicago and Pennsylvania State University.

The scientific community has largely assumed that planets covered in a deep ocean would not support the cycling of minerals and gases that keeps the climate stable on Earth, and thus wouldn't be friendly to life. But the study, published Aug. 30 in The *Astrophysical Journal*, found that ocean planets could stay in the "sweet spot" for habitability much longer than previously assumed. The authors based their findings on more than a thousand simulations.

"This really pushes back against the idea you need an Earth clone -- that is, a planet with some land and a shallow ocean," said Edwin Kite, assistant professor of geophysical sciences at UChicago and lead author of the study.

As telescopes get better, scientists are finding more and more planets orbiting stars in other solar systems. Such discoveries are resulting in new research into how life could potentially survive on other planets, some of which are very different from Earth -- some may be covered entirely in water hundreds of miles deep.

Because life needs an extended period to evolve, and because the light and heat on planets can change as their stars age, scientists usually look for planets that have both some water and some way to keep their climates stable over time. The primary method we know of is how Earth does it. Over long timescales, our planet cools itself by drawing down greenhouse gases into minerals and warms itself up by releasing them via volcanoes.

But this model doesn't work on a water world, with deep water covering the rock and suppressing volcanoes.

Kite, and Penn State coauthor Eric Ford, wanted to know if there was another way. They set up a simulation with thousands of randomly generated planets, and tracked the evolution of their climates over billions of years.

"The surprise was that many of them stay stable for more than a billion years, just by luck of the draw," Kite said. "Our best guess is that it's on the order of 10 percent of them."

These lucky planets sit in the right location around their stars. They happened to have the right amount of carbon present, and they don't have too many minerals and elements from the crust dissolved in the oceans that would pull carbon out of the atmosphere. They have enough water from the start, and they cycle carbon between the atmosphere and ocean only, which in the right concentrations is sufficient to keep things stable.

"How much time a planet has is basically dependent on carbon dioxide and how it's partitioned between the ocean, atmosphere and rocks in its early years," said Kite. "It does seem there is a way to keep a planet habitable long-term without the geochemical cycling we see on Earth."

The simulations assumed stars that are like our own, but the results are optimistic for red dwarf stars, too, Kite said. Planets in red dwarf systems are thought to be promising candidates for fostering life because these stars get brighter much more slowly than our sun -- giving life a much longer time period to get started. The same conditions modeled in this paper could be applied to planets around red dwarfs, they said: Theoretically, all you would need is the steady light of a star.

Story Source:

Materials provided by **University of Chicago**. *Note: Content may be edited for style and length.*

Robotic herding of a flock of birds using drones -- ScienceDaily

Researchers made a new algorithm for enabling a single robotic unmanned aerial vehicle to herd a flock of birds away from a designated airspace. This novel approach allows a single autonomous quadrotor drone to herd an entire flock of birds away without breaking their formation.

Professor David Hyunchul Shim at KAIST in collaboration with Professor Soon-Jo Chung of Caltech and Professor Aditya Paranjape of Imperial College London investigated the problem of diverting a flock of birds away from a prescribed area, such as an airport, using a robotic UVA. A novel boundary control strategy called the m-waypoint algorithm was introduced for enabling a single pursuer UAV to safely herd the flock without fragmenting it.

The team developed the herding algorithm on the basis of macroscopic properties of the flocking model and the response of the flock. They tested their robotic autonomous drone by successfully shepherding an entire flock of birds out of a designated airspace near KAIST's campus in Daejeon, South Korea. This study is published in *IEEE Transactions on Robotics*.

"It is quite interesting, and even awe-inspiring, to monitor how birds react to threats and collectively behave against threatening objects through the flock. We made careful observations of flock dynamics and interactions between flocks and the pursuer. This allowed us to create a new herding algorithm for ideal flight paths for incoming drones to move the flock away from a protected airspace," said Professor Shim, who leads the Unmanned Systems Research Group at KAIST.

Bird strikes can threaten the safety of airplanes and their passengers. Korean civil aircraft suffered more than 1,000 bird strikes between 2011 and 2016. In the US, 142,000 bird strikes destroyed 62 civilian airplanes, injured 279 people, and killed 25 between 1990 and 2013. In the UK in 2016, there were

1,835 confirmed bird strikes, about eight for every 10,000 flights. Bird and other wildlife collisions with aircraft cause well over 1.2 billion USD in damages to the aviation industry worldwide annually. In the worst case, Canadian geese knocked out both engines of a US Airway jet in January 2009. The flight had to make an emergency landing on the Hudson River.

Airports and researchers have continued to reduce the risk of bird strikes through a variety of methods. They scare birds away using predators such as falcons or loud noises from small cannons or guns. Some airports try to prevent birds from coming by ridding the surrounding areas of crops that birds eat and hide in.

However, birds are smart. "I was amazed with the birds' capability to interact with flying objects. We thought that only birds of prey have a strong sense of maneuvering with the prey. But our observation of hundreds of migratory birds such as egrets and loons led us to reach the hypothesis that they all have similar levels of maneuvering with the flying objects. It will be very interesting to collaborate with ornithologists to study further with birds' behaviors with aerial objects," said Professor Shim. "Airports are trying to transform into smart airports. This algorithm will help improve safety for the aviation industry. In addition, this will also help control avian influenza that plagues farms nationwide every year," he stressed.

For this study, two drones were deployed. One drone performed various types of maneuvers around the flocks as a pursuer of herding drone, while a surveillance drone hovered at a high altitude with a camera pointing down for recording the trajectories of the pursuer drone and the birds.

During the experiments on egrets, the birds made frequent visits to a hunting area nearby and a large number of egrets were found to return to their nests at sunset. During the time, the team attempted to fly the herding drone in various directions with respect to the flock.

The drone approached the flock from the side. When the birds noticed the drone, they diverted from their original paths and flew at a 45? angle to their right. When the birds noticed the drone while it was still far away, they adjusted their paths horizontally and made smaller changes in the vertical direction. In the second round of the experiment on loons, the drone flew

almost parallel to the flight path of a flock of birds, starting from an initial position located just off the nominal flight path. The birds had a nominal flight speed that was considerably higher than that of the drone so the interaction took place over a relatively short period of time.

Professor Shim said, "I think we just completed the first step of the research. For the next step, more systems will be developed and integrated for bird detection, ranging, and automatic deployment of drones." "Professor Chung at Caltech is a KAIST graduate. And his first student was Professor Paranjape who now teaches at Imperial. It is pretty interesting that this research was made by a KAIST faculty member, an alumnus, and his student on three different continents," he said.

Mongrel Mob gang opens up to New Zealand researchers for the good of their health -- ScienceDaily

Studying the liver health of a high-risk, hard-to-reach gang population certainly came with challenges and a few surprises, a University of Otago academic says.

The research, published today in *Royal Society Open Science*, assessed the hepatitis prevalence, knowledge, and liver health risk factors of 52 Mongrel Mob members, affiliates and extended family.

Associate Professor Michael Schultz, Head of the Department of Medicine, says New Zealand has a high percentage of undiagnosed hepatitis B and C cases.

The Mongrel Mob is the largest gang in New Zealand and, thanks to known risk factors for hepatitis C, such as a high incarceration rate, common intravenous drug use, and uncertified tattooing, their members and relatives are considered to be a high-risk hepatitis C group.

"Knowledge of hepatitis and how it is transmitted are essential for disease prevention and management," he says.

Dr Schultz says the researchers were provided with a unique opportunity to study the Mongrel Mob, a group considered to be hard-to-reach and marginalised, generating the first data of this kind.

While no cases of hepatitis C were found, two carriers of hepatitis B were identified.

Of most concern was the "marginal" knowledge the study participants had about viral hepatitis. On average, the participants scored 43.3 per cent on a knowledge questionnaire, compared to 59.4 per cent in the general

population.

"Knowledge about some aspects of viral hepatitis, such as risk factors, transmission, symptoms and treatment options was very low," Dr Schultz says.

The researchers found a significant link between lack of knowledge and risky infection behaviours among the group.

"Education is key to stopping hepatitis C from spreading. This study demonstrates the need for educational screening programmes to aid early detection, prevention and treatment," he says.

The researchers also identified several areas of concern about the general liver health of the group: participants displayed three times higher rates of liver inflammation and damage compared to the general population; one-fifth had significant to severe levels of liver fibrosis and cirrhosis; exceptionally high levels of alcohol consumption, in both frequency and quantity, were identified; and the group was found to have more than two times higher obesity rates than the general population.

"Given that about 35 per cent of the group visited their GP less than once every five years, they are highly concerning findings," Dr Schultz says.

While surprised by the willingness of the participants to be involved in the study, Dr Schultz believed having a person on the team who came from a gang family helped break the ice.

"While the planning wasn't all that easy, once there, everybody was really open, interested, and asked questions. We felt welcome, not threatened at all. They were very nice and co-operative and really interested, despite what we think we know about the Mongrel Mob.

"I see this as one of the most interesting and challenging projects I have done. It certainly took me out of my comfort zone."

He was particularly pleased the study provided a unique opportunity to engage with an entire community, and provide knowledge that disseminated

outside the immediate study group.

The Mongrel Mob has also worked with Otago academics to study lung function and smoking habits. Dr Schultz believes there is scope to also work with the gang on projects targeting diabetes and hypertension, though nothing is currently planned.

As it proved such a successful model for community-based educational health intervention, the study format could also be extended to other subjects.

"With some persistence and good planning, it is possible to reach these people."

How a NASA scientist looks in the depths of the great red spot to find water on Jupiter -- ScienceDaily

For centuries, scientists have worked to understand the makeup of Jupiter. It's no wonder: this mysterious planet is the biggest one in our solar system by far, and chemically, the closest relative to the Sun. Understanding Jupiter is a key to learning more about how our solar system formed, and even about how other solar systems develop.

But one critical question has bedeviled astronomers for generations: Is there water deep in Jupiter's atmosphere, and if so, how much?

Gordon L. Bjoraker, an astrophysicist at NASA's Goddard Space Flight Center in Greenbelt, Maryland, reported in a recent paper in the *Astronomical Journal* that he and his team have brought the Jovian research community closer to the answer.

By looking from ground-based telescopes at wavelengths sensitive to thermal radiation leaking from the depths of Jupiter's persistent storm, the Great Red Spot, they detected the chemical signatures of water above the planet's deepest clouds. The pressure of the water, the researchers concluded, combined with their measurements of another oxygen-bearing gas, carbon monoxide, imply that Jupiter has 2 to 9 times more oxygen than the sun. This finding supports theoretical and computer-simulation models that have predicted abundant water (H2O) on Jupiter made of oxygen (O) tied up with molecular hydrogen (H2).

The revelation was stirring given that the team's experiment could have easily failed. The Great Red Spot is full of dense clouds, which makes it hard for electromagnetic energy to escape and teach astronomers anything about the chemistry within.

"It turns out they're not so thick that they block our ability to see deeply," said Bjoraker. "That's been a pleasant surprise."

New spectroscopic technology and sheer curiosity gave the team a boost in peering deep inside Jupiter, which has an atmosphere thousands of miles deep, Bjoraker said: "We thought, well, let's just see what's out there."

The data Bjoraker and his team collected will supplement the information NASA's Juno spacecraft is gathering as it circles the planet from north to south once every 53 days.

Among other things, Juno is looking for water with its own infrared spectrometer and with a microwave radiometer that can probe deeper than anyone has seen -- to 100 bars, or 100 times the atmospheric pressure at Earth's surface. (Altitude on Jupiter is measured in bars, which represent atmospheric pressure, since the planet does not have a surface, like Earth, from which to measure elevation.)

If Juno returns similar water findings, thereby backing Bjoraker's ground-based technique, it could open a new window into solving the water problem, said Goddard's Amy Simon, a planetary atmospheres expert.

"If it works, then maybe we can apply it elsewhere, like Saturn, Uranus or Neptune, where we don't have a Juno," she said.

Juno is the latest spacecraft tasked with finding water, likely in gas form, on this giant gaseous planet.

Water is a significant and abundant molecule in our solar system. It spawned life on Earth and now lubricates many of its most essential processes, including weather. It's a critical factor in Jupiter's turbulent weather, too, and in determining whether the planet has a core made of rock and ice.

Jupiter is thought to be the first planet to have formed by siphoning the elements left over from the formation of the Sun as our star coalesced from an amorphous nebula into the fiery ball of gases we see today. A widely accepted theory until several decades ago was that Jupiter was identical in composition to the Sun; a ball of hydrogen with a hint of helium -- all gas, no

core.

But evidence is mounting that Jupiter has a core, possibly 10 times Earth's mass. Spacecraft that previously visited the planet found chemical evidence that it formed a core of rock and water ice before it mixed with gases from the solar nebula to make its atmosphere. The way Jupiter's gravity tugs on Juno also supports this theory. There's even lightning and thunder on the planet, phenomena fueled by moisture.

"The moons that orbit Jupiter are mostly water ice, so the whole neighborhood has plenty of water," said Bjoraker. "Why wouldn't the planet -- which is this huge gravity well, where everything falls into it -- be water rich, too?"

The water question has stumped planetary scientists; virtually every time evidence of H2O materializes, something happens to put them off the scent. A favorite example among Jupiter experts is NASA's Galileo spacecraft, which dropped a probe into the atmosphere in 1995 that wound up in an unusually dry region. "It's like sending a probe to Earth, landing in the Mojave Desert, and concluding the Earth is dry," pointed out Bjoraker.

In their search for water, Bjoraker and his team used radiation data collected from the summit of Maunakea in Hawaii in 2017. They relied on the most sensitive infrared telescope on Earth at the W.M. Keck Observatory, and also on a new instrument that can detect a wider range of gases at the NASA Infrared Telescope Facility.

The idea was to analyze the light energy emitted through Jupiter's clouds in order to identify the altitudes of its cloud layers. This would help the scientists determine temperature and other conditions that influence the types of gases that can survive in those regions.

Planetary atmosphere experts expect that there are three cloud layers on Jupiter: a lower layer made of water ice and liquid water, a middle one made of ammonia and sulfur, and an upper layer made of ammonia.

To confirm this through ground-based observations, Bjoraker's team looked at wavelengths in the infrared range of light where most gases don't absorb

heat, allowing chemical signatures to leak out. Specifically, they analyzed the absorption patterns of a form of methane gas. Because Jupiter is too warm for methane to freeze, its abundance should not change from one place to another on the planet.

"If you see that the strength of methane lines vary from inside to outside of the Great Red Spot, it's not because there's more methane here than there," said Bjoraker, "it's because there are thicker, deep clouds that are blocking the radiation in the Great Red Spot."

Bjoraker's team found evidence for the three cloud layers in the Great Red Spot, supporting earlier models. The deepest cloud layer is at 5 bars, the team concluded, right where the temperature reaches the freezing point for water, said Bjoraker, "so I say that we very likely found a water cloud." The location of the water cloud, plus the amount of carbon monoxide that the researchers identified on Jupiter, confirms that Jupiter is rich in oxygen and, thus, water.

Bjoraker's technique now needs to be tested on other parts of Jupiter to get a full picture of global water abundance, and his data squared with Juno's findings.

"Jupiter's water abundance will tell us a lot about how the giant planet formed, but only if we can figure out how much water there is in the entire planet," said Steven M. Levin, a Juno project scientist at NASA's Jet Propulsion Laboratory in Pasadena, Calif.

New Zealand penguins make mammoth migrations, traveling thousands of kilometers to feed: Tawaki penguins swim up to 80 km per day to reach their feeding grounds -- ScienceDaily

Tawaki penguins migrate from their breeding sites on the west coast of New Zealand's South Island, where they feed at sea for several weeks to refuel after long periods of fasting on land while rearing chicks. To find out where the seabirds go, the authors attached satellite transmitters to 10 male and 7 female adult Tawaki penguins from November 2016 to March 2017, and compared the migration routes with published oceanographic data such as surface temperature and currents. Tags on nine birds continued emitting data up until they turned back for the return journey, and five were tracked for the entire migration.

They found that the penguins travelled between 3,500 and 6,800 km on their 69-day migration -- making theirs one of the longest penguin pre-moult migrations recorded to date. The birds travelled between 20km and 80km per day -- which the authors suggest may be close to the upper limit for penguin swimming.

Penguins travelled south west from the colony before heading to one of two feeding grounds -- one near the subtropical front (STF), south of Tasmania, and one further south near the subantarctic front (SAF). Birds that left the breeding site earlier in the season tended to head to the STF, and travelled 750 km shorter on average. The authors suggest that successful breeders may be more likely to depart late because of the demands of parenting, and have to swim faster to reach the more distant feeding grounds in the SAF.

Mattern notes: "The penguins leave the New Zealand coast at a time when the ocean's productivity is nearing its peak, so from that perspective, travelling

thousands of kilometers seem to make little sense. We believe that this extraordinary behavior could be a remnant from an ancestral penguin species that evolved further south in the sub-Antarctic region before populating the New Zealand mainland. This would also explain why the species breeding range is concentrated to the southern coastlines of New Zealand; if breeding further north, this migratory behavior would simply not be feasible."

Story Source:

Materials provided by **PLOS**. *Note: Content may be edited for style and length.*

Switching to hunter-gatherer lifestyle may increase diversity in children's gut microbes -- ScienceDaily

An international team of researchers has shown that immersing city dwellers in the traditional lifestyle and diet of a rainforest village for two weeks increases the diversity of the visiting children's -- but not the adults' -- gut microbiota. In a small pilot study published this week in *mSphere*®, an open-access journal of the American Society for Microbiology, the team shows that the immersion visit did little to shift the adults' skin, oral, nasal and fecal microbiota.

"We wanted to look at the question of whether microbiota change during a drastic, radical change of diet and lifestyle," says Maria Gloria Dominguez-Bello, a microbial ecologist at Rutgers University in New Brunswick, New Jersey who led the study with microbiologist Monica Contreras from the Venezuelan Institute of Scientific Research. "In this village, there was no market economy, no bodega, no Coca-Cola -- so this represented a radical shift in diet from a high percentage of processed foods in urban places to zero processed foods and an all-natural diet."

Dominguez-Bello, along with researchers from New York University and two Venezuelan institutes, took advantage of a visit planned by five, city-dwelling adult visitors -- and two of their children -- to live among an indigenous Yekwana village in the Bolivar State of Venezuela for 16 days. The village has a hunter-gatherer-gardener lifestyle and diet.

Typical fare includes cassava (a starchy, high-fiber tuber), corn, various wild fruits, including plantains, pineapples, and berries, fish, and small amounts of game meat and eggs gathered from wild birds. Visitors had two meals a day that consisted of soup with a bit of fish or meat. The rest of their diet consisted of "all-day snacking on cassava with fruit" says Dominguez-Bello. The visitors also bathed in the river without soap and followed the natural

circadian rhythms of their hosts.

"The diet contains very little animal protein and it's very, very high in fiber and very low in fat," compared to Western diets, says Dominguez-Bello.

While it is known that people with traditional diets have higher gut microbiota diversity compared to those with urban diets, it was unknown if urban dwellers could shift the diversity of their microbiota higher simply by following a traditional lifestyle and diet. In the gut, a high diversity of microbes is considered a sign of good health.

Traditional people eat diets rich in unprocessed plant material, which are much more chemically complex compared to processed foods. The smorgasbord of chemicals acts as fuel for a higher variety of microbes. Traditional people use less antimicrobial medicines and compounds in daily life, which might also contribute to their increased gut microbe diversity.

During the 16-day visit, the researchers collected samples from the visitors' skin, mouth, nose, and from a fecal swab. Age-matched samples were also collected from villagers. The samples were sequenced and compared.

Surprisingly, none of the adult visitors' microbiota shifted significantly during the visit, while the two children's gut microbiota trended toward a higher number of total microbial species present. Although these results were not statistically significant and in just two subjects, the researchers saw this as interesting nonetheless, given the children's ages of 4 and 7.

Up to now, it was thought that children's gut microbiota become stable and more 'adult-like' by the time they reach 3 years of age. "This indicates that the window for maturing your microbiome may not be 3 years of age, but longer," says Dominguez-Bello. Her team plans to do a larger study with 12 children participating in an "immersion summer camp" to a traditional village.

Because the children's gut microbiota exhibited more plasticity, these results raise an interesting possibility that urban children who eat a more traditional, high-fiber, low-fat and low-processed diet early in life might cultivate a more diverse set of gut microbes. Conversely, adults may have a limited response

due to their low microbiome plasticity.

Dominguez-Bello was not terribly surprised that the adults' gut and other microbiota changed so little: "If you take traditional people and bring them to New York, give them antibiotics and McDonald's to eat everyday, it's not surprising that they lose diversity," she says. "But if, as an urban dweller, you've already lost that gut microbe diversity and you move to a high-diversity diet, maybe you cannot 'bloom' diversity because you simply don't have those microbes present anymore."

Mammal forerunner that reproduced like a reptile sheds light on brain evolution -- ScienceDaily

Compared with the rest of the animal kingdom, mammals have the biggest brains and produce some of the smallest litters of offspring. A newly described fossil of an extinct mammal relative -- and her 38 babies -- is among the best evidence that a key development in the evolution of mammals was trading brood power for brain power.

The find is among the rarest of the rare because it contains the only known fossils of babies from any mammal precursor, said researchers from The University of Texas at Austin who discovered and studied the fossilized family. But the presence of so many babies -- more than twice the average litter size of any living mammal -- revealed that it reproduced in a manner akin to reptiles. Researchers think the babies were probably developing inside eggs or had just recently hatched when they died.

The study, published in the journal *Nature* on Aug. 29, describes specimens that researchers say may help reveal how mammals evolved a different approach to reproduction than their ancestors, which produced large numbers of offspring.

"These babies are from a really important point in the evolutionary tree," said Eva Hoffman, who led research on the fossil as a graduate student at the UT Jackson School of Geosciences. "They had a lot of features similar to modern mammals, features that are relevant in understanding mammalian evolution."

Hoffman co-authored the study with her graduate adviser, Jackson School Professor Timothy Rowe.

The mammal relative belonged to an extinct species of beagle-size plant-eaters called Kayentatherium wellesi that lived alongside dinosaurs about 185

million years ago. Like mammals, Kayentatherium probably had hair.

When Rowe collected the fossil more than 18 years ago from a rock formation in Arizona, he thought that he was bringing a single specimen back with him. He had no idea about the dozens of babies it contained.

Sebastian Egberts, a former graduate student and fossil preparator at the Jackson School, spotted the first sign of the babies years later when a grain-sized speck of tooth enamel caught his eye in 2009 as he was unpacking the fossil.

"It didn't look like a pointy fish tooth or a small tooth from a primitive reptile," said Egberts, who is now an instructor of anatomy at the Philadelphia College of Osteopathic Medicine. "It looked more like a molariform tooth (molar-like tooth) -- and that got me very excited."

A CT scan of the fossil revealed a handful of bones inside the rock. However, it took advances in CT-imaging technology during the next 18 years, the expertise of technicians at UT Austin's High-Resolution X-ray Computed Tomography Facility, and extensive digital processing by Hoffman to reveal the rest of the babies -- not only jaws and teeth, but complete skulls and partial skeletons.

The 3D visualizations Hoffman produced allowed her to conduct an in-depth analysis of the fossil that verified that the tiny bones belonged to babies and were the same species as the adult. Her analysis also revealed that the skulls of the babies were like scaled-down replicas of the adult, with skulls a tenth the size but otherwise proportional. This finding is in contrast to mammals, which have babies that are born with shortened faces and bulbous heads to account for big brains.

The brain is an energy-intensive organ, and pregnancy -- not to mention childrearing -- is an energy-intensive process. The discovery that Kayentatherium had a tiny brain and many babies, despite otherwise having much in common with mammals, suggests that a critical step in the evolution of mammals was trading big litters for big brains, and that this step happened later in mammalian evolution.

"Just a few million years later, in mammals, they unquestionably had big brains, and they unquestionably had a small litter size," Rowe said.

The mammalian approach to reproduction directly relates to human development -- including the development of our own brains. By looking back at our early mammalian ancestors, humans can learn more about the evolutionary process that helped shape who we are as a species, Rowe said.

"There are additional deep stories on the evolution of development, and the evolution of mammalian intelligence and behavior and physiology that can be squeezed out of a remarkable fossil like this now that we have the technology to study it," he said.

Funding for the research was provided by the National Science Foundation, The University of Texas Geology Foundation and the Jackson School of Geosciences.

Unstoppable monster in the early universe: ALMA obtains most detailed view of distant starburst galaxy -- ScienceDaily

Astronomers obtained the most detailed anatomy chart of a monster galaxy located 12.4 billion light-years away. Using the Atacama Large Millimeter/submillimeter Array (ALMA), the team revealed that the molecular clouds in the galaxy are highly unstable, which leads to runaway star formation. Monster galaxies are thought to be the ancestors of the huge elliptical galaxies in today's universe, therefore these findings pave the way to understand the formation and evolution of such galaxies.

"One of the best parts of ALMA observations is to see the far-away galaxies with unprecedented resolution," says Ken-ichi Tadaki, a postdoctoral researcher at the Japan Society for the Promotion of Science and the National Astronomical Observatory of Japan, the lead author of the research paper published in the journal *Nature*.

Monster galaxies, or starburst galaxies, form stars at a startling pace; 1000 times higher than the star formation in our Galaxy. But why are they so active? To tackle this problem, researchers need to know the environment around the stellar nurseries. Drawing detailed maps of molecular clouds is an important step to scout a cosmic monster.

Tadaki and the team targeted a chimerical galaxy COSMOS-AzTEC-1. This galaxy was first discovered with the James Clerk Maxwell Telescope in Hawai`i, and later the Large Millimeter Telescope (LMT) in Mexico found an enormous amount of carbon monoxide gas in the galaxy and revealed its hidden starburst. The LMT observations also measured the distance to the galaxy, and found that it is 12.4 billion light-years (Note).

Researchers have found that COSMOS-AzTEC-1 is rich with the ingredients of stars, but it was still difficult to figure out the nature of the cosmic gas in

the galaxy. The team utilized the high resolution and high sensitivity of ALMA to observe this monster galaxy and obtain a detailed map of the distribution and the motion of the gas. Thanks to the most extended ALMA antenna configuration of 16 km, this is the highest resolution molecular gas map of a distant monster galaxy ever made.

"We found that there are two distinct large clouds several thousand light-years away from the center," explains Tadaki. "In most distant starburst galaxies, stars are actively formed in the center. So it is surprising to find off-center clouds."

The astronomers further investigated the nature of the gas in COSMOS-AzTEC-1 and found that the clouds throughout the galaxy are very unstable, which is unusual. In a normal situation, the inward gravity and outward pressure are balanced in the clouds. Once gravity overcomes pressure, the gas cloud collapses and forms stars at a rapid pace. Then, stars and supernova explosions at the end of the stellar life cycle blast out gases, which increase the outward pressure. As a result, the gravity and pressure reach a balanced state and star formation continues at a moderate pace. In this way star formation in galaxies is self-regulating. But, in COSMOS-AzTEC-1, the pressure is far weaker than the gravity and hard to balance. Therefore this galaxy shows runaway star formation and has morphed into an unstoppable monster galaxy.

The team estimated that the gas in COSMOS-AzTEC-1 will be completely consumed in 100 million years, which is 10 times faster than in other star forming galaxies.

But why is the gas in COSMOS-AzTEC-1 so unstable? Researchers do not have a definitive answer yet, but galaxy merger is a possible cause. Galaxy collision may have efficiently transported the gas into a small area and ignited intense star formation.

"At this moment, we have no evidence of merger in this galaxy. By observing other similar galaxies with ALMA, we want to unveil the relation between galaxy mergers and monster galaxies," summarizes Tadaki.

Story Source:

Diplomats' mystery illness linked to radiofrequency/microwave radiation, researcher says -- ScienceDaily

Her conclusions, she said, may aid in the treatment of the diplomats (and affected family members) and assist U.S. government agencies seeking to determine the precise cause. More broadly, Golomb said her research draws attention to a larger population of people who are affected by similar health problems.

"I looked at what's known about pulsed RF/MW in relation to diplomats' experiences," said Golomb. "Everything fits. The specifics of the varied sounds that the diplomats reported hearing during the apparent inciting episodes, such as chirping, ringing and buzzing, cohere in detail with known properties of so-called 'microwave hearing,' also known as the Frey effect.

"And the symptoms that emerged fit, including the dominance of sleep problems, headaches and cognitive issues, as well as the distinctive prominence of auditory symptoms. Even objective findings reported on brain imaging fit with what has been reported for persons affected by RF/MW radiation."

Beginning in 2016, personnel at the U.S. Embassy in Havana, Cuba (as well as Canadian diplomats and family members) described hearing strange sounds, followed by development of an array of symptoms. The source of the health problems has not been determined. Though some officials and media have described the events as "sonic attacks," some experts on sound have rejected this explanation. In May of this year, the State Department reported that U.S. government employees in Guangzhou, China had also experienced similar sounds and health problems.

Affected diplomats and family members from both locations were medically evacuated to the U.S. for treatment, but despite multiple government

investigations, an official explanation of events and subsequent illnesses has not been announced. At least two early published studies examining available data were inconclusive.

In her paper, scheduled to be published September 15 in *Neural Computation*, Golomb compared rates of described symptoms among diplomats with a published 2012 study of symptoms reported by people affected by electromagnetic radiation in Japan. By and large, she said the cited symptoms -- headache, cognitive problems, sleep issues, irritability, nervousness or anxiety, dizziness and tinnitus (ringing in the ears) -- occurred at strikingly similar rates.

Some diplomats reported hearing loss. That symptom was not assessed in both studies so rates could not be compared, but Golomb said it is widely reported in both conditions. She also noted that previous brain imaging research in persons affected by RF/ EMR "showed evidence of traumatic brain injury, paralleling reports in diplomats."

David O. Carpenter, MD, is director of the Institute for Health and the Environment at the University of Albany, part of the State University of New York. He was not involved in Golomb's study. He said evidence cited by Golomb illustrates "microwave hearing," which results "from heating induced in tissue, which causes 'waves' in the ear and results in clicks and other sounds." Reported symptoms, he said, characterize the syndrome of electrohypersensitivity (EHS), in which unusual exposure to radiofrequency radiation can trigger symptoms in vulnerable persons that may be permanent and disabling.

"We have seen this before when the Soviets irradiated the U.S. Embassy in Moscow in the days of the Cold War," he said.

Golomb, whose undergraduate degree was in physics, conducts research investigating the relationship of oxidative stress and mitochondrial function -- mechanisms shown to be involved with RF/EMR injury -- to health, aging, behavior and illness. Her work is wide-ranging, with published studies on Gulf War illness, statins, antibiotic toxicity, ALS, autism and the health effects of chocolate and trans fats, with a secondary interest in research methods, including placebos.

Golomb said an analysis of 100 studies examining whether low-level RF produced oxidative injury found that 93 studies concluded that it did. Oxidative injury or stress arises when there is an imbalance between the production of reactive oxygen species (free radicals) and the body's detoxifying antioxidant defenses. Oxidative stress has been linked to a range of diseases and conditions, from Alzheimer's disease, autism and depression to cancer and chronic fatigue syndrome, as well as toxic effects linked to certain drugs and chemicals. More to the point, Golomb said, oxidative injury has been linked to the symptoms and conditions reported in diplomats.

The health consequences of RF/MW exposure is a matter of on-going debate. Some government agencies, such as the National Institute of Environmental Health Sciences and the National Cancer Institute, publicly assert that low- to mid-frequency, non-ionizing radiation like those from microwaves and RF is generally harmless. They cite studies that have found no conclusive link between exposure and harm.

But others, including researchers like Golomb, dispute that conclusion, noting that many of the no-harm studies were funded by vested industries or had other conflicts of interest. She said independent studies over decades have reported biological effects and harms to health from nonionizing radiation, specifically RF/MW radiation, including via oxidative stress and downstream mechanisms, such as inflammation, autoimmune activation and mitochondrial injury.

Golomb compared the situation to persons with peanut allergies: Most people do not experience any adverse effect from peanut exposure, but for a vulnerable subgroup, exposure produces negative, even life-threatening, consequences.

In her analysis, Golomb concludes that "of hypotheses tendered to date, (RF/MW exposure) alone fits the facts, including the peculiar ones" regarding events in Cuba and China. She said her findings advocate for more robust attention to pulsed RF/MW and associated adverse health effects.

"The focus must be on research by parties free from ties to vested interests. Such research is needed not only to explain and address the symptoms in diplomats, but also for the benefit of the small fraction -- but large number --

of persons outside the diplomatic corps, who are beset by similar problems."

Goats prefer happy people -- ScienceDaily

Goats can differentiate between human facial expressions and prefer to interact with happy people, according to a new study led by scientists at Queen Mary University of London.

The study, which provides the first evidence of how goats read human emotional expressions, implies that the ability of animals to perceive human facial cues is not limited to those with a long history of domestication as companions, such as dogs and horses.

Writing in the journal *Royal Society Open Science*, the team describe how 20 goats interacted with images of positive (happy) and negative (angry) human facial expressions and found that they preferred to look and interact with the happy faces.

Dr Alan McElligott who led the study at Queen Mary University of London and is now based at the University of Roehampton, said: "The study has important implications for how we interact with livestock and other species, because the abilities of animals to perceive human emotions might be widespread and not just limited to pets."

The study, which was carried out at Buttercups Sanctuary for Goats in Kent, involved the researchers showing goats pairs of unfamiliar grey-scale static human faces of the same individual showing happy and angry facial expressions.

The team found that images of happy faces elicited greater interaction in the goats who looked at the images, approached them and explored them with their snouts. This was particularly the case when the happy faces were positioned on the right of the test arena suggesting that goats use the left hemisphere of their brains to process positive emotion.

First author Dr Christian Nawroth, who worked on the study at Queen Mary University of London but is now based at Leibniz Institute for Farm Animal

Biology, said: "We already knew that goats are very attuned to human body language, but we did not know how they react to different human emotional expressions, such as anger and happiness. Here, we show for the first time that goats do not only distinguish between these expressions, but they also prefer to interact with happy ones."

The research has implications for understanding how animals process human emotions.

Co-author Natalia Albuquerque, from the University of Sao Paulo, said: "The study of emotion perception has already shown very complex abilities in dogs and horses. However, to date, there was no evidence that animals such as goats were capable of reading human facial expressions. Our results open new paths to understanding the emotional lives of all domestic animals."

Story Source:

Materials provided by **Queen Mary University of London**. *Note: Content may be edited for style and length.*

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