https://go.nature.com/3ts19m6

An ice core from cold-war days reveals Greenland's green and balmy past

The island lived up to its name one million years ago, when the ice sheet of today was missing.

Long-frozen areas of Greenland were ice-free in warmer periods of the past — a potentially bad omen for the fate of the island's massive ice sheet.

To understand the history of Greenland's climate, Andrew Christ at the University of Vermont in Burlington and his colleagues analysed sediment at the bottom of an ice core from northwestern Greenland, which is now covered by a 1.4-kilometre-thick ice sheet. The core was drilled by scientists at a US military base in 1966, the height of the cold war.

The sediments' chemical and isotopic signatures hint that the surrounding land surface was sporadically exposed when the ice sheet was absent. The ice seems to have melted away and reformed at least once in the past million years, the researchers conclude. Fossil remains of plants in the sediment suggest that vegetation flourished in a mostly ice-free environment in that same time period. The rate of ice-sheet melting and recovery in the past provides clues to how much Greenland's shrinking ice sheet might contribute to sea-level rise in a warming climate, the scientists say.

Proc. Natl Acad. Sci. USA (2021)

http://bit.ly/3s2e3XS

Geologists Have a New Tool for Reconstructing the Ancient Climate

A new study of seafloor sediments finds that the temperature record in the early Paleozoic corresponds to significant shifts in the diversity of life on Earth.

Clara Chaisson, Science Writer

The early Paleozoic era was an action-packed stretch when it came to the diversity of life on Earth.

First came the Cambrian explosion, when most of the major animal groups first burst onto the scene. The great Ordovician biodiversification event followed—species richness skyrocketed, and life spread from shallow seafloors and shorelines across entire oceans. Then, around 445 million years ago, the Late Ordovician mass extinction became the first of the "big five" mass extinctions on record. Some 85% of all marine species vanished forever.

New research published in the *Proceedings of the National Academy of Sciences of the United States of America* details the climatic conditions during this period of boom and bust between 541 million and 443 million years ago using an often-overlooked material: ancient seafloor mud, in the form of limestone. The findings showed a strong link between changes in climate and changes in biodiversity.

Microbes flourished when temperatures were hotter during the early part of the study period, the authors found. When it cooled down during the Ordovician, animal life took off. An unstable climate and glaciation led up to the Late Ordovician mass extinction.

"The Cambrian-Ordovician is such an exciting interval…it really felt like a worthwhile period to go in and do a very high resolution study on," said Kristin Bergmann, a professor in the Department of Earth, Atmospheric and Planetary Sciences at Massachusetts Institute of Technology (MIT) and a coauthor on the new study.

Paleoclimatologists can't make direct measurements of what temperatures were like thousands or millions of years ago. Instead, they rely on "paleothermometers," or proxies that contain preserved physical records of past conditions. Examples of climate proxies include tree rings, ice cores, shells, and sediments. Each type of proxy has its particular uses depending on the time period and conditions in question.

A lot can happen in a span of hundreds of millions of years, though, and these physical records have the potential to become distorted over time. Shells from marine animals are the gold standard for many geologists reconstructing ancient climates because they tend to be more physically resistant to later alteration than other proxy materials. As an added bonus, their structure makes it relatively straightforward for scientists to determine whether they've been altered. Shells are composed of calcium carbonate that precipitates out from seawater, and the oxygen isotope ratio of a given shell contains information about the water temperature at which it precipitated.

There's just one catch: Shells haven't been around forever. That's a problem for geologists interested in the early Paleozoic or earlier. "As you go too far back in time in evolution, animals had not yet evolved the ability to make shells," said Sam Goldberg, a Ph.D. student in geology at MIT and the lead author of the study. "Only really in the past 500 million years do these shells even exist." Even then, shells from the earliest days of their evolution tend to be thin and poorly preserved.

Out of the Mud, a Clearer Climate Record Emerges

Ancient mud is "all over the geologic record," but geologists haven't relied on it for climate reconstructions because of the assumption that muds are more susceptible to chemical changes than shells are. Ancient mud, on the other hand, is "all over the geologic record," Goldberg said. Carbonate mud from the seafloor contains calcium carbonates from tiny, shelled microbes as well as direct precipitation from seawater. (Over time, carbonate mud becomes limestone.)

Carbonate mud is abundant and contains the same chemical compound as shells, but geologists haven't relied on it for climate reconstructions because of the assumption that muds are more susceptible to chemical changes than shells are. As the sediment is buried and eventually converts to sedimentary rock, it can be exposed to water and heat that throw off the oxygen isotope ratio from the time of the calcium carbonate's formation.

Goldberg and his coauthors challenged that assumption by testing carbonate mud samples from Svalbard (Norway) and Newfoundland (Canada) that appeared to be well preserved. After collecting rock samples from both sites, they ran a clumped-isotope analysis, which looks for pairs of isotopes that indicate whether water exposure significantly altered the oxygen isotope ratio of the original formation conditions. They found that the oxygen isotope composition of the samples was relatively unchanged, making them a viable option for climate reconstruction.

Because shelled animals evolved during the time period the researchers were analyzing, they could check their mud-based temperature reconstruction against a lower-resolution temperature reconstruction based on tried-and-true fossil records. It was a match. "The paper is a welcome addition to previous clumped isotope paleothermometry efforts…and…a significant step forward in improving the fidelity of the earliest parts of the Phanerozoic record," Gregory Henkes, an assistant professor in the Department of Geosciences at Stonybrook University who was not involved with the study, wrote in an email.

The study's findings also match up with existing models that link the early Paleozoic's leaps and bounds in animal evolution to cooling of previously warm oceans, though Henkes noted that the description of very high ocean temperatures in particular "warrants further testing against paleoclimate models."

Goldberg said that although it's difficult to draw direct comparisons to today's climate, one thing is clear: "Animal life doesn't like it when it gets too hot."

Now that the researchers know their methods for analyzing carbonate mud work, they hope to use the same methods to go even

further back in geologic and evolutionary time—something Bergmann's lab is working on.

It turns out "clear as mud" can actually be a good thing—when it comes to paleoclimatology, at least.

Citation: *Chaisson, C. (2021), Geologists have a new tool for reconstructing the ancient climate, Eos, 102, https://doi.org/10.1029/2021EO155909. Published on 15 March 2021.*

http://bit.ly/3eLPSJ9

An ancient Maya ambassador's bones show a life of privilege and hardship

Ajpach' Waal forged an alliance between two dynasties but died in obscurity

Author: Holly Ober

An important Maya man buried nearly 1,300 years ago led a privileged yet difficult life. The man, a diplomat named Ajpach' Waal, suffered malnutrition or illness as a child, but as an adult he helped negotiate an alliance between two powerful dynasties that ultimately failed. The ensuing political instability left him in reduced economic circumstances, and he probably died in relative obscurity.

During excavations at El Palmar, a small plaza compound in Mexico near the borders of Belize and Guatemala, archaeologists led by Kenichiro Tsukamoto, an assistant professor of anthropology at UC Riverside, discovered a hieroglyph-adorned stairway leading up to a ceremonial platform. When deciphered, the hieroglyphs revealed that in June, 726 CE, Ajpach' Waal traveled and met the king of Copán, 350 miles away in Honduras, to forge an alliance with the king of Calakmul, near El Palmar.

The findings, published in the journal Latin American Antiquity, shed light on the role communities peripheral to major centers played in cementing connections between royal families during the Late Classic period (600–800 CE), and the ways they might suffer when something shattered those alliances.

The inscriptions identified Ajpach' Waal as a "lakam," or standard-bearer, an ambassador that carried a banner as they walked on diplomatic missions between cities. He inherited this lofty position through his father's lineage, and his mother also came from an elite family. Ajpach' Waal must have considered this his crowning achievement because the hieroglyphs indicate he was not given the platform by El Palmar's ruler, but had it built it for himself a few months after the mission in September, 726 CE. The platform served as a sort of theatrical stage where spectacular rituals were performed for an audience, with only influential people able to build their own.

Beneath the floor of a temple next to the platform, Tsukamoto discovered the undisturbed burial of a male skeleton in a small chamber. Though interred in a location that suggested ownership of the platform and temple, unlike other elite Maya burials, only two colorfully decorated clay pots — no jewelry or other grave goods — had accompanied this individual into the underworld.

In the new paper, Tsukamoto and Jessica I. Cerezo-Román, an assistant professor of anthropology at the University of Oklahoma, study the bones of the person buried in this puzzling tomb to tell his story.

"His life is not like we expected based on the hieroglyphics," Tsukamoto said. "Many people say that the elite enjoyed their lives, but the story is usually more complex."

Dental inlays of jade and pyrite in teeth from a burial in a non-royal elite Maya tomb at El Palmar, Mexico. **(Kenichiro Tsukamoto)**

The man was between 35 and 50 years old when he died. Several dating methods, including radiocarbon, stratigraphy, and ceramic typology, suggest the burial occurred around 726, when the

stairway was constructed. The high status of the individual combined with proximity to the stairway lead the authors to believe that this was probably Ajpach' Waal himself, or possibly his father.

All his upper front teeth, from right canine to left, had been drilled to hold decorative implants of pyrite and jade, which was valuable and highly regulated. Maya living in geographic areas associated with ruling elites underwent this painful procedure during puberty as a rite of passage to mark their inclusion within a high office or social group. Ajpach' Waal might have received such implants when he inherited his father's title.

The skull had been mildly flattened in back from prolonged contact with something flat during infancy, which the Maya believed made a person more attractive. Because the front of the cranium was not preserved, the archaeologists could not tell if the forehead had been similarly flattened, a beautification practice limited to royalty.

Other aspects of the bones belied the privilege displayed by the dental and cranial modifications. Some of his arm bones had healed periostitis, caused by bacterial infections, trauma, scurvy, or rickets, which would have made his arm ache until the condition improved. Both sides of the skull had slightly porous, spongy areas known as porotic hyperostosis, caused by childhood nutritional deficiencies or illnesses. The condition is relatively common in burials throughout the Maya world, suggesting Ajpach' Waal's high status couldn't shield him from malnutrition and disease.

A healed fracture on his right tibia, or shinbone, resembles fractures seen in modern athletes who play contact sports such as football, rugby, or soccer. This could indicate he played some of the ballgames depicted on the stairway, strengthening the case that this was Ajpach' Waal.

Long before he died, the individual had lost many teeth on the left side of his lower jaw due to gum disease and might have had a painful abscess on his lower right premolar, all of which would have restricted his diet to soft foods. One inlaid tooth had thickened near the root in response to the injury of drilling and could have ached.

He also developed arthritis in his hands, right elbow, left knee, left ankle, and feet as he aged, which would have caused stiffness and pain, especially in the morning. Tsukamoto and Cerezo-Román suggest that his arthritis might have been caused by carrying a banner on a pole for long distances over rugged terrain and walking and up and down stairways. He would have also been required to kneel on the platforms of Maya rulers.

As if these maladies weren't enough, fate conspired to change Ajpach' Waal's fortunes.

"The ruler of a subordinate dynasty decapitated Copán's king 10 years after his alliance with Calakmul, which was also defeated by a rival dynasty around the same time," Tsukamoto said. "We see the political and economic instability that followed both these events in the sparse burial and in one of the inlaid teeth."

The archaeologists determined that the inlay in Ajpach' Waal's right canine tooth had fallen out and was not replaced before his death because dental plaque had hardened into calculus in the cavity. The hole, easily visible when the man smiled or spoke, would have been an embarrassing, public admission of hardship or El Palmar's reduced significance. This also would have made him a less useful emissary if he still occupied the role.

Though people continued living at El Palmar for some time after Ajpach' Waal's death, it was eventually abandoned and reclaimed by the jungle.

The paper, "The Life Course of a Standard-Bearer: A Nonroyal Elite Burial at the Maya Archaeological Site of El Palmar, Mexico," is available here.

https://go.nature.com/30QX12P

Where has all Mars's water gone? The answer might be well buried

A leading theory says that the red planet lost its ancient water to space, but research suggests that Martian minerals sucked up some of it.

Much of the water that once flowed across Mars is now locked up in minerals in the planet's rocks.

Geological features, such as channels and shorelines, on Mars show that rivers and oceans covered much of the planet eons ago. Over time, that water vanished, leaving the planet mostly arid, except for ice at its poles and beneath its surface. One leading theory is that the water escaped to space.

Eva Scheller at the California Institute of Technology in Pasadena and her colleagues used observations from spacecraft and data from Martian meteorites to develop a detailed picture of where those ancient oceans might have gone.

The team's models show that during the first one billion to 2 billion years of Martian history, roughly a third to nearly all of the water on the planet's surface became incorporated into minerals in its crust. As rocks on the surface weathered, they sequestered water from the atmosphere.

This process is at least as important as atmospheric escape in explaining the drying of Mars. *Science* (2021)

http://bit.ly/3bUETeH

What sparked life on Earth? Perhaps bolts from the blue

Lightning strikes -- perhaps a quintillion of them, occurring over a billion years -- may have provided sparks of life for the early Earth.

A new study by researchers at Yale and the University of Leeds contends that over time, these bolts from the blue unlocked the phosphorus necessary for the creation of biomolecules that would be the basis of life on the planet.

"This work helps us understand how life may have formed on Earth and how it could still be forming on other, Earth-like planets," said lead author Benjamin Hess, a graduate student in Yale's Department of Earth & Planetary Sciences.

In part, it starts with phosphorus, Hess said.

Phosphorus is a key ingredient necessary for the formation of life -- but it was not easily accessible on Earth billions of years ago. For the most part, phosphorus was locked tightly inside insoluble minerals on Earth's surface.

The question for researchers has been: How did Earth's phosphorus get into a usable form to help create DNA, RNA, and other biomolecules needed for life?

Scientists looked first at meteorites. The idea was that meteorites containing the phosphorus mineral schreibersite -- which is soluble in water -- crashed on Earth's surface with enough frequency to create the conditions necessary for biological life.

The drawback to the meteorite theory, however, had to do with frequency. During the period when life is thought to have begun, anywhere from 3.5 to 4.5 billion years ago, the frequency of meteorite collisions on Earth plummeted.

But there was another source of the phosphorus found in schreibersite. According to Hess, schreibersite can also be found in certain glasses -- called fulgurites -- that form when lightning strikes the ground. The glass contains some of the phosphorus from surface rock, but in soluble form.

Using results from computer modeling, Hess and co-authors Sandra Piazolo and Jason Harvey from the University of Leeds estimated that early Earth saw 1 to 5 billion lightning flashes every year (compared to about 560 million flashes per year today). Of those

early flashes, anywhere from 100 million to 1 billion would have struck the ground annually.

That would add up to 0.1 to 1 quintillion strikes -- and quite a bit of usable phosphorus -- after a billion years.

The lightning strike theory has other advantages as well, the researchers noted. First, the annual number of lightning strikes would have remained constant, unlike the number of meteorite collisions. In addition, lightning strikes were likely to be most prevalent on land masses in tropical regions, providing more concentrated areas of usable phosphorus. "It makes lightning strikes a significant pathway toward the origin of life," Hess said.

The new study appears in the journal Nature Communications. Financial support from Yale helped fund the research.

http://wb.md/3c1oOEc

Herbal Extract Promising as Male Contraceptive in Animal Trials

An extract of an herb used in traditional Chinese medicine works as a reversible oral contraceptive in male mice and monkeys, researchers say.

Laird Harrison

Triptonide, extracted from the herb *Tripterygium wilfordii Hook F (雷公藤)*, did not appear to cause any side effects in the animals, said Wei Yan, MD, PhD, an investigator at the Lundquist Institute for Biomedical Innovation, Harbor-UCLA Medical Center, Torrance, California. "This is the tenth or eleventh compound we tested," Yan told *Medscape Medical News*, "and right away I realized this is it. Bingo. We got it."

Yan and his colleagues are now seeking funding to complete pharmacology and toxicology studies on triptonide. If those are promising, they plan to start human clinical trials. Their study was published in *Nature Communications.*

If triptonide finds its way to market, it will hit a target that researchers have been missing for decades.

Worldwide, half of all pregnancies are unintended, and half of unplanned pregnancies end in abortion, suggesting that current methods of contraception are falling short, Yan said.

Although there are many alternatives for women, including oral drugs, men have only condoms, vasectomy, withdrawal, and the avoidance of penetration, which have varying degrees of efficacy.

"I don't think it's fair to ask women to take pills, and men cause the trouble and don't take responsibility," Yan said.

Researchers have had difficulty finding pharmaceutical means to control the male half of the reproductive process. Female oral contraceptives use hormones to mimic pregnancy, which is a time during which women are naturally infertile. No such phase exists for men. And although women release one egg a month, men produce a thousand sperm every second, any one of which can fertilize the egg.

It has proved very hard to kill all those sperm without hurting the man who makes them, Yan said. So he hit on the idea of crippling the sperm instead.

Disrupting Sperm Development

Searching for compounds that might achieve this goal, he came across literature on *T wilfordii Hook F*, commonly known as lei gong teng. or thunder god vine. Practitioners of traditional Chinese medicine use it to treat rheumatoid arthritis and other autoimmune and inflammatory diseases. He said that with more than 3 months of use, it can cause male infertility. It appears to interrupt the development of the sperm, causes malformations, and lowers sperm counts and motility.

In the 1980s, studies of two compounds isolated from the herb, triptolide and tripchlorolide, caused such severe liver toxicity in rats that researchers abandoned those investigations.

Focusing instead on a less abundant compound in the herb,

triptonide, Yan and his colleagues got much better results.

In an initial study to determine the best dose in mice, they found that a dose of 0.8 mg/kg body weight per day produced sperm with heads bent backward. Such sperm are not able to travel to find an egg, they determined. The drug didn't cause any measurable ill effects on the mice.

They fed the drug to 12 male mice for 4 weeks, then mated each of these males to two fertile female mice. Although the mice copulated, none of the female mice became pregnant. After a washout period, the male mice were able to impregnate female mice.

The researchers ran a similar series of studies in macaque monkeys. They found that a dose of 0.1 mg/kg body weight per day caused deformations in more than 95% of the sperm in these monkeys. The researchers treated four male monkeys for up to 126 weeks. None of them showed any major health effects.

Yet, the treated male monkeys were unable to impregnate fertile female monkeys. After the researchers stopped treating the male monkeys for about 40 days, the animals' sperm returned to their normal shapes, and the monkeys were again able to impregnate female monkeys.

Sperm counts were lower in the treated monkeys than in the control monkeys, but the difference was not statistically significant.

"I'm excited about the paper," said John Amory, MD, MPH, a professor of medicine at the University of Washington, Seattle, Washington. "We've struggled, those of us interested in developing a male contraceptive."

Research has shown that most women would trust their partners to use an oral contraceptive, he said. "And men account for 30% of contraception now, so they're using the contraceptives they have available," he said. Amory emphasized that the triptonide research is still in early stages. He and his colleagues continue to work on a hormonal approach to male contraception.

Yan and Amory have disclosed no relevant financial relationships.

Nat Commun. Published online February 23, 2021. Full text

https://go.nature.com/3eSkOrm

Rare birds in Australia have forgotten how to sing their own song

Without elder instructors of their own kind, young regent honeyeaters are adapting the songs of other species.

Critically endangered regent honeyeaters are forgetting their songs because there are few elder birds to pass them on.

Regent honeyeaters are so scarce that young males don't get voice lessons from older birds. **Credit: Jan Wegener/BIA/Minden Pictures/Alamy**

The yellow-speckled, nectar-eating honeyeaters (*Anthochaera phrygia*), which live in Australia, learn their complex courting and territorial songs from other birds. So when populations are very small, there's no one for young honeyeaters to learn from.

Ross Crates at the Australian National University in Canberra and his team located more than 100 male honeyeaters by combining data from a monitoring programme with public sightings reported to the conservation group BirdLife Australia. The researchers recorded the birds' songs and compared them with historical recordings.

Overall, 27% of males sang songs that differed from the typical melodies. Some 12% had resorted to singing the songs of other bird species.

As habitat loss and competition from bigger birds threaten honeyeaters, the loss of their songs could accelerate their decline, the researchers say. Without a common song to bring them together, the birds might simply fail to mate.

Proc. R. Soc. B (2021)

http://bit.ly/3s3LhWL

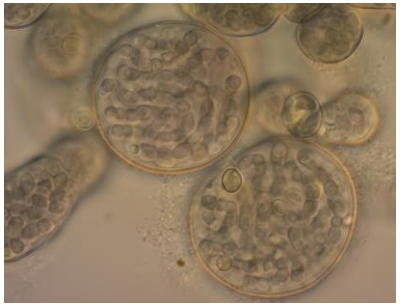
Photosynthesis could be as old as life itself

Researchers find that the earliest bacteria had the tools to perform a crucial step in photosynthesis, changing how we think life evolved on Earth.

by Hayley Dunning, Imperial College London

The finding also challenges expectations for how life might have evolved on other planets. The evolution of photosynthesis that produces oxygen is thought to be the key factor in the eventual emergence of complex life. This was thought to take several billion years to evolve, but if in fact the earliest life could do it, then other planets may have evolved complex life much earlier than previously thought.

The research team, led by scientists from Imperial College London, traced the evolution of key proteins needed for photosynthesis back to possibly the origin of bacterial life on Earth. Their results are published and freely accessible in BBA—Bioenergetics.



Colonies of cyanobacteria under the microscope. **Credit: Ye.Maltsev/Shutterstock**

Lead researcher Dr. Tanai Cardona, from the Department of Life Sciences at Imperial, said: "We had previously shown that the biological system for performing oxygen-production, known as Photosystem II, was extremely old, but until now we hadn't been able to place it on the timeline of life's history.

"Now, we know that Photosystem II shows patterns of evolution that are usually only attributed to the oldest known enzymes, which were crucial for life itself to evolve."

Early oxygen production

Photosynthesis, which converts sunlight into energy, can come in two forms: one that produces oxygen, and one that doesn't. The oxygen-producing form is usually assumed to have evolved later, particularly with the emergence of cyanobacteria, or blue-green algae, around 2.5 billion years ago.

While some research has suggested pockets of oxygen-producing (oxygenic) photosynthesis may have been around before this, it was still considered to be an innovation that took at least a couple of billion years to evolve on Earth.

The new research finds that enzymes capable of performing the key process in oxygenic photosynthesis—splitting water into hydrogen and oxygen—could actually have been present in some of the earliest bacteria. The earliest evidence for life on Earth is over 3.4 billion years old and some studies have suggested that the earliest life could well be older than 4.0 billion years old.

Like the evolution of the eye, the first version of oxygenic photosynthesis may have been very simple and inefficient; as the earliest eyes sensed only light, the earliest photosynthesis may have been very inefficient and slow.

On Earth, it took more than a billion years for bacteria to perfect the process leading to the evolution of cyanobacteria, and two billion years more for animals and plants to conquer the land. However, that oxygen production was present at all so early on means in other environments, such as on other planets, the transition to complex life could have taken much less time.

Measuring molecular clocks

The team made their discovery by tracing the 'molecular clock' of key photosynthesis proteins responsible for splitting water. This method estimates the rate of evolution of proteins by looking at the time between known evolutionary moments, such as the emergence of different groups of cyanobacteria or land plants, which carry a version of these proteins today. The calculated rate of evolution is then extended back in time, to see when the proteins first evolved.

They compared the evolution rate of these photosynthesis proteins to that of other key proteins in the evolution of life, including those that form energy storage molecules in the body and those that translate DNA sequences into RNA, which is thought to have originated before the ancestor of all cellular life on Earth. They also compared the rate to events known to have occurred more recently, when life was already varied and cyanobacteria had appeared.

The photosynthesis proteins showed nearly identical patterns of evolution to the oldest enzymes, stretching far back in time, suggesting they evolved in a similar way.

First author of the study Thomas Oliver, from the Department of Life Sciences at Imperial, said: "We used a technique called Ancestral Sequence Reconstruction to predict the protein sequences of ancestral photosynthetic proteins.

Cyanobacteria on a water surface. **Credit: Kletr/Shutterstock**

"These sequences give us information about how the ancestral Photosystem II would have worked and we were able to show that many of the key components required for oxygen evolution in Photosystem II can be traced to the earliest stages in the evolution of the enzyme."

Directing evolution

Knowing how these key photosynthesis proteins evolve is not only relevant for the search for life on other planets, but could also help researchers find strategies to use photosynthesis in new ways through synthetic biology.

Dr. Cardona, who is leading such a project as part of his UKRI Future Leaders Fellowship, said: "Now we have a good sense of how photosynthesis proteins evolve, adapting to a changing world, we can use 'directed evolution' to learn how to change them to produce new kinds of chemistry. "We could develop photosystems that could carry out complex new green and sustainable chemical reactions entirely powered by light."

More information: *Thomas Oliver et al. Time-resolved comparative molecular evolution of oxygenic photosynthesis, Biochimica et Biophysica Acta (BBA) - Bioenergetics (2021). DOI: 10.1016/j.bbabio.2021.148400*

http://bit.ly/3cKBXRe

French coronavirus variant can't be detected by PCR tests

New strain doesn't appear to be more transmissible or more serious than others, but it seems to be undetectable with current PCR tests

By Chris Smith

We'll need coronavirus vaccine booster shots for the foreseeable future to ensure continued protection against COVID-19 as the novel coronavirus mutates. That's what Sharon Peacock, the head of COVID-19 Genomics UK (COG-UK), told *Reuters* earlier this week. The scientist leads researchers whose job is to sequence as many coronavirus strains as possible and assess risks. The coronavirus mutates about once every two weeks, and three variants are currently of concern.

The B.1.1.7 mutant from the UK is more infectious and deadly than progenitors, but responds well to vaccines. The South African (B.1.351) and Brazilian (P.1) strains can reinfect COVID-19 survivors and reduce vaccine effectiveness. Peacock said that she was primarily worried about the South African variant, warning that there might be other variants out there they haven't even discovered.

The French health ministry just confirmed Peacock's prediction, announcing the discovery of a new coronavirus variant on Monday. The new strain doesn't appear to be more transmissible or more serious than others, but it does have one unexpected ability: It seems to be undetectable with current PCR tests.

The health ministry said that the new variant was found in a cluster of eight cases in a hospital in Lannion in the French region of

Brittany, *France 24* reports. But several of those cases had not been detected via PCR tests. Per *Bloomberg*, the authorities sequenced samples from eight patients from a bigger cluster of 79 at the hospital.

The PCR test is the standard for diagnosing COVID-19. It's been used from the early days of the pandemic, with the world having now reached a point where people can get tested with relative ease. Quick antigen tests are also available, but PCR tests are the primary diagnosis tool for COVID.

It's unclear why the Brittany version of the coronavirus has been able to avoid detection. Such a development is worrying if this strain were to be highly infectious, as existing coronavirus tests might not pick it up. The virus could continue to spread undetected. PCR tests can be updated to continue detecting new strains, but the new kits would also have to detect existing strains.

French officials said that researchers at the Institut Pasteur are already analyzing the genetic changes that might have allowed the French mutant to avoid detection.

"Investigations will take place to determine how this variant reacts to vaccination and to antibodies developed during prior COVID infections," Brittany's regional health authority said in a statement.

Even without a PCR test to pick up the illness, the symptoms COVID-19 patients might show could be enough for clinicians to suspect an infection with the novel coronavirus. Genetic testing would confirm the presence of the virus, although they would take longer than PCR.

The following video briefly explains how PCR testing works so well in diagnosing COVID-19. The test targets specific gene segments particular to SARS-CoV-2 to deliver a positive diagnosis. If the French variant has suffered genetic changes at all the gene sites that the PCR test covers, test results could deliver false-negative results. The UK, South African, and Brazilian variants each feature several distinct mutations, so it's possible the French strain might also have a few distinct genetic changes.

http://bit.ly/3eUG27W

Models show Earth's heat loss is higher on one side of the planet

A team of researchers at the University of Oslo has found evidence that shows Earth's heat loss is more pronounced on one side of the planet than the other.

by Bob Yirka , Phys.org

In their paper published in the journal *Geophysical Research Letters*, the group describes creating models that represent Earth's heat loss over the past 400 million years and what they showed.

Prior research has shown that heat inside of the Earth makes its way to the surface, where it dissipates. Heat inside the Earth comes about from the degradation of radioactive elements and is also left over from the collisions that occurred between asteroids that led to the creation of the planet. In this new effort, the researchers have found that the heat inside the planet does not escape uniformly across the surface.

Prior research efforts looking into Earth's heat loss were only able to go back in time approximately 240 million years. In this new effort, the researchers were able to create models showing the geography of the Earth going back 400 million years ago. Over that time, the continents have shifted quite dramatically, from supercontinents to the arrangement that exists today. To make their model, the researchers started by calculating how much heat has been lost over their period of study. They found it to be approximately 149 Kelvin per billion years of cooling. They also added data that described how much heat is able to move through different types of surface areas and data describing the movement of the continents. Heat is able to move much more efficiently through the crust beneath the oceans, they note, than through the

crust below continents.

The model showed that more heat was escaping from the parts of the planet that were covered with large oceans, specifically the Pacific Ocean. They found that if they cut the planet in half at the 60 degree longitude line, the half of the planet that consists mainly of the Pacific Ocean allowed much more heat to escape than the hemisphere that includes Africa, Europe and Asia. Calculations showed that the Pacific Hemisphere has cooled approximately 50 degrees more than the African hemisphere over the past 400 million years.

More information: *Krister S. Karlsen et al. Spatiotemporal Variations in Surface Heat Loss Imply a Heterogeneous Mantle Cooling History, Geophysical Research Letters (2021). DOI: 10.1029/2020GL092119*

http://bit.ly/3bXxfAi

This golden box will soon make oxygen on Mars. That's great news for human explorers.

Car-size robot will help pave the way for future humans to travel to our neighboring world

By Adam Mann - Live Science Contributor

Having safely landed on Mars on Feb. 18, NASA's newest rover, Perseverance, is just beginning its scientific exploration of the Red Planet. But sometime in the next few weeks, the car-size robot will also help pave the way for future humans to travel to our neighboring world with a small instrument known as the Mars Oxygen In-Situ Resource Utilization Experiment (MOXIE).

Technicians carefully lower the Mars Oxygen In-Situ Resource Utilization Experiment (MOXIE) instrument into the belly of the Perseverance rover. **(Image credit: NASA/JPL-Caltech)**

MOXIE, which will soon be pulling precious oxygen out of Mars' poisonous atmosphere, is gold-colored and about the size of a bread box. It sits tucked away inside Perseverance's chassis, where it will conduct the first demonstration on another planet of what's known as in-situ resource utilization (ISRU), meaning using local resources for exploration rather than bringing all the necessary materials from Earth.

NASA has long been interested in ISRU and put out a call for an oxygen-producing experiment when Perseverance was first being conceived, Eric Daniel Hinterman, an aerospace engineering doctoral student at the Massachusetts Institute of Technology and member of the MOXIE team, told Live Science.

While oxygen is useful for astronauts to breathe, Hinterman said that it's even more important as rocket propellant. When combined with hydrogen, oxygen combusts in a powerful explosion that is used to lift many modern rockets from their launch pads.

In addition to the propellant needed to get off Earth and fly to Mars, a spacecraft bringing humans to the Red Planet would need between 66,000 and 100,000 pounds (30,000 and 45,000 kilograms) of oxygen to return home, according to NASA. "We can send that oxygen from Earth to Mars, but if we can make it on the surface that potentially saves us a lot of money," Hinterman said.

Any additional oxygen produced through ISRU technology could go into life-support systems for astronauts while on the surface of Mars, Hinterman said.

In order to reach the ground, Perseverance had to go through a complicated sky crane maneuver and the famous "seven minutes of terror" that subjected all of its components to some fairly extreme forces. A few days after landing, the MOXIE team put the instrument through a series of what are known as "aliveness" tests to make sure it was in working order.

"We had it turn on and send some data [to confirm] that it survived," Hinterman said. "When we got the data, we popped

some champagne and celebrated."

Though MOXIE's first oxygen-producing run hasn't been scheduled yet, it is expected to happen sometime in the rover's first months on the Red Planet. The instrument uses a technology called solid oxygen electrolysis, Hinterman said.

This process involves taking in a small sample of the Martian atmosphere, which is almost entirely carbon dioxide, a molecule containing one carbon atom and two oxygen atoms. MOXIE will heat the air up to nearly 1500 degrees Fahrenheit (800 degrees Celsius) and apply a voltage across it. That should split the carbon dioxide apart, producing carbon monoxide and a single oxygen atom.

MOXIE won't be storing any of the oxygen it produces, simply verifying that the element was successfully made and then releasing it back to the atmosphere, said Hinterman. It's only a small prototype about 200 times smaller than a similar machine that would be used on a future human mission, he added.

The experiment will run many times over the course of a Martian year — "on a hot summer's day, on a cold winter's night, and during a global or local dust storm," Hinterman said — to ensure that it can work under a wide variety of conditions.

That's because a scaled-up version of MOXIE would be critical infrastructure on an eventual human mission. Though the technology works on Earth, "to really be confident in something that humans will rely on for survival, it's important to test that technology on Mars," said Hinterman.

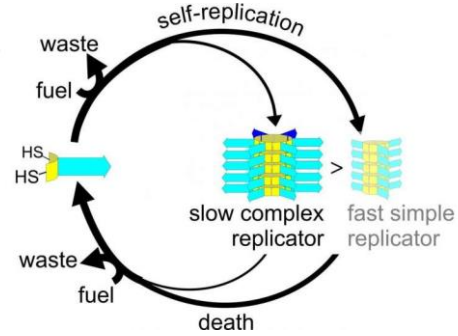
He is excited to be part of a project that is helping to demonstrate something important for human Mars exploration and is confident that such a mission will happen in the coming decades. "I'm dedicating my career to getting humans to Mars," he said. "If we don't have humans on Mars within my lifetime, I'll take it personally."

http://bit.ly/3lu1npW

Death enables complexity in chemical evolution

Simple systems can reproduce faster than complex ones. So, how can the complexity of life have arisen from simple chemical beginnings?

Starting with a simple system of self-replicating fibers, chemists at the University of Groningen have discovered that upon introducing a molecule that attacks the replicators, the more complex structures have an advantage. This system shows the way forward in elucidating how life can originate from lifeless matter. The results were published on 10 March in the journal *Angewandte Chemie*.



The life cycle of complex and more simple replicators. The complex replicators are produced at a slower rate than the simple replicators, but as they are more resistant to breakdown ('death'), they can gain the upper hand.
Credit: Sijbren Otto, University of Groningen

The road to answering the question of how life originated is guarded by Spiegelman's monster, named after the American molecular biologist Sol Spiegelman, who some 55 years ago described the tendency of replicators to become smaller when they were allowed to evolve. "Complexity is a disadvantage during replication, so how did the complexity of life evolve?" asked Sijbren Otto, Professor of Systems Chemistry at the University of Groningen. He previously developed a self-replicating system in which self-replication produces fibers from simple building blocks and, now, he has found a way to beat the monster.

Death

"To achieve this, we introduced death into our system," Otto explains. His fibers are made up of stacked rings that are self-

assembled from single building blocks. The number of building blocks in a ring can vary, but stacks always contain rings of the same size. Otto and his team tweaked the system in such a way that rings of two different sizes were created, containing either three or six building blocks.

Under normal circumstances, fibers that are made up of small rings will outgrow the fibers with larger rings. "However, when we added a compound that breaks up rings inside the fibers, we found that the bigger rings were more resistant. This means that the more complex fibers will dominate, despite the smaller rings replicating faster. Fibers that are made from small rings are more easily "killed."'

Experiments

Otto acknowledges that the difference in complexity between the two types of fibers is small. "We did find that the fibers from the larger rings were better catalysts for the benchmark retro-aldol reaction than the simpler fibers that are made from rings with three building blocks. But then again, this reaction doesn't benefit the fibers." However, the added complexity protects the fibers from destruction, probably by shielding the sulfur-sulfur bonds that link the building blocks into rings.

"All in all, we have now shown that it is possible to beat Spiegelman's monster," says Otto. "We did this in a particular way, by introducing chemical destruction, but there may be other routes. For us, the next step is to find out how much complexity we can create in this manner." His team is now working on a way to automate the reaction, which depends on a delicate balance between the processes of replication and destruction. "At the moment, it needs constant supervision and this limits the time that we can run it."

Variants

The new system is the first of its kind and opens a route to more complex chemical evolution. "In order to achieve real Darwinian evolution that leads to new things, we will need more complex systems with more than one building block," says Otto. The trick will be to design a system that allows for the right amount of variation. "When you have unlimited variation, the system won't go anywhere, it will just produce small amounts of all kinds of variants." In contrast, if there is very little variation, nothing really new will appear.

The results that were presented in the latest paper show that, starting from simple precursors, complexity can increase in the course of evolution. "This means that we can now see a way forward. But the journey to producing artificial life through chemical evolution is still a long one," says Otto. However, he has beaten the monster guarding the road to his destination.

More information: *Shuo Yang et al, Chemical Fueling Enables Molecular Complexification of Self-Replicators, Angewandte Chemie International Edition (2021). DOI: 10.1002/anie.202016196*

http://bit.ly/3c4bxe4

Feeding cattle seaweed reduces their greenhouse gas emissions 82 percent

Steer fed a small amount of seaweed resulted in a dramatic drop in methane emissions.

A bit of seaweed in cattle feed could reduce methane emissions from beef cattle as much as 82 percent, according to new findings from researchers at the University of California, Davis. The results, published today in the journal *PLOS ONE*, could pave the way for the sustainable production of livestock throughout the world.

"We now have sound evidence that seaweed in cattle diet is effective at reducing greenhouse gases and that the efficacy does not diminish over time," said Ermias Kebreab, professor and Sesnon Endowed Chair of the Department of Animal Science and director of the World Food Center. Kebreab conducted the study along with his Ph.D. graduate student Breanna Roque.

"This could help farmers sustainably produce the beef and dairy products we need to feed the world," Roque added.

Over the course of five months last summer, Kebreab and Roque added scant amounts of seaweed to the diet of 21 beef cattle and tracked their weight gain and methane emissions. Cattle that consumed doses of about 80 grams (3 ounces) of seaweed gained as much weight as their herd mates while burping out 82 percent less methane into the atmosphere. Kebreab and Roque are building on their earlier work with dairy cattle, which was the world's first experiment reported that used seaweed in cattle.

Less gassy, more sustainable

Greenhouse gases are a major cause of climate change, and methane is a potent greenhouse gas. Agriculture is responsible for 10 percent of greenhouse gas emissions in the U.S., and half of those come from cows and other ruminant animals that belch methane and other gases throughout the day as they digest forages like grass and hay.

Since cattle are the top agricultural source of greenhouse gases, many have suggested people eat less meat to help address climate change. Kebreab looks to cattle nutrition instead.

"Only a tiny fraction of the earth is fit for crop production," Kebreab explained. "Much more land is suitable only for grazing, so livestock plays a vital role in feeding the 10 billion people who will soon inhabit the planet. Since much of livestock's methane emissions come from the animal itself, nutrition plays a big role in finding solutions."

In 2018, Kebreab and Roque were able to reduce methane emissions from dairy cows by over 50 percent by supplementing their diet with seaweed for two weeks. The seaweed inhibits an enzyme in the cow's digestive system that contributes to methane production.

In the new study, Kebreab and Roque tested whether those reductions were sustainable over time by feeding cows a touch of seaweed every day for five months, from the time they were young on the range through their later days on the feed lot.

Four times a day, the cows ate a snack from an open-air contraption that measured the methane in their breath. The results were clear. Cattle that consumed seaweed emitted much less methane, and there was no drop-off in efficacy over time.

Next steps

Results from a taste-test panel found no differences in the flavor of the beef from seaweed-fed steers compared with a control group. Similar tests with dairy cattle showed that seaweed had no impact on the taste of milk.

Also, scientists are studying ways to farm the type of seaweed—Asparagopsis taxiformis—that Kebreab's team used in the tests. There is not enough of it in the wild for broad application.

Another challenge: How do ranchers provide seaweed supplements to grazing cattle on the open range? That's the subject of Kebreab's next study.

Kebreab and Roque collaborated with a federal scientific agency in Australia called the Commonwealth Scientific and Industrial Research Organization, James Cook University in Australia, Meat and Livestock Australia, and Blue Ocean Barns, a startup company that sources, processes, markets and certifies seaweed-based additives to cattle feed. Kebreab is a scientific adviser to Blue Ocean Barns.

"There is more work to be done, but we are very encouraged by these results," Roque said. "We now have a clear answer to the question of whether seaweed supplements can sustainably reduce livestock methane emissions and its long term effectiveness."

More information: *Roque BM, Venegas M, Kinley RD, de Nys R, Duarte TL, Yang X, et al. (2021) Red seaweed (Asparagopsis taxiformis) supplementation reduces enteric methane by over 80 percent in beef steers. PLoS ONE 16(3): e0247820.* *doi.org/10.1371/journal.pone.0247820*

http://bit.ly/2PbBQpq

Scientists may have figured out how SARS-CoV-2 jumped from animals to humans

A WHO investigative team fixates on wildlife farms in China as a point of origin for the virus

By Matthew Rozsa

The origin story for the novel coronavirus was always a bit nebulous. We know the outbreak began in Wuhan, China; and the discovery of SARS-CoV-2 antibodies in bats and pangolins in Thailand suggested that the virus may have crossed over from those animals. But the data points in-between animals, and a human in Wuhan, were never entirely clear.

Now, there's been a break in the case. A member of a World Health Organization (WHO) investigative team told NPR earlier this week that they believe southern Chinese wildlife farms were most likely the source of the outbreak; they noted that the Chinese government shut down these farms in February 2020. Although the team's findings are expected to be released within the next two weeks, members are sharing their main takeaways now. They suspect these wildlife farms were the spot in which the SARS-CoV-2 virus spilled over from a bat into another animal before entering human beings.

"They take exotic animals, like civets, porcupines, pangolins, raccoon dogs and bamboo rats, and they breed them in captivity," Peter Daszak, who works for EcoHealth Alliance as a disease ecologist and is a member of the WHO team that visited China this year, told NPR. WHO investigators uncovered new evidence that those wildlife farms were working with the Huanan Seafood Wholesale Market in Wuhan, which could explain how an outbreak at the farms would have moved to that market.

As Daszak pointed out, the Chinese government had promoted farming wildlife as a method of helping rural communities lift themselves out of poverty. Economically, the strategy had worked well, and resulted in billions of dollars of new investment and millions of jobs for rural Chinese. This made it all the more striking that on Feb. 24, 2020 state officials announced it would stop wildlife farming for food, even though the Wuhan outbreak was winding down.

"They sent out instructions to the farmers about how to safely dispose of the animals — to bury, kill or burn them — in a way that didn't spread disease," Daszak explained. His team speculates that this is because they believed those farms were the spot of spillover for the virus. "I do think that SARS-CoV-2 first got into people in South China. It's looking that way."

Another member of the WHO investigative team, virologist Linfa Wang of the Duke-NUS Medical School in Singapore, echoed those thoughts.

"There was massive transmission going on at that market for sure," Wang told NPR. He later added, "In the live animal section, they had many positive samples. They even have two samples from which they could isolate live virus."

The COVID-19 pandemic caused a spike in anti-Chinese sentiment, with President Donald Trump and many of his Republican supporters describing the virus in racist language and blaming the Chinese government for the outbreak. Despite the scapegoating of China, the available information suggests that the government did a lot to help other countries as the pandemic began to break out.

"I worked very closely with a group of Chinese scientists and doctors who were on the frontline at the outbreak in Wuhan last year, and I can honestly say that the world owes them a debt of gratitude for the way they fought this outbreak when it first took place," Dr. Richard Horton, editor-in-chief of the medical journal "The Lancet," told Salon last month. He noted how Chinese scientists sequenced the SARS-CoV-2 genome and posted what

they learned, wrote up the initial case descriptions and warned that the virus posed a significant danger in terms of person-to-person transmission. "They raised the alarm about the risk of a global pandemic," Horton added.

WHO officials believe that the definitive details about how the virus first broke out will become clear in the next few years.

"I'm convinced we're going to find out fairly soon," Daszak told The Wall Street Journal. "Within the next few years we'll have real significant data on where this came from and how it emerged."

http://bit.ly/3s74oPs

Long COVID Symptoms Are Vanishing For Some Vaccinated Patients, And We Don't Know Why

A woman who had long COVID said her symptoms were gone 36 hours after getting her second dose of COVID-19 vaccine, according to The Washington Post.

Marianne Guenot

Arianna Eisenberg, 34, said she experienced muscle pains, insomnia, fatigue, and brain fog for eight months after getting sick. These symptoms are typical of what has become known as "long COVID". But 36 hours after receiving a second dose of COVID-19 vaccine, her symptoms were gone, the *Post* reported. Eisenberg's story is one of several describing a similar effect. The *Philadelphia Inquirer* and the Huffington Post also reported on people for whom long COVID symptoms improved after vaccination.

Daniel Griffith, an infectious diseases clinician and researcher at Columbia University, told The Verge on March 2 that around a third of his long COVID patients reported that they were feeling better after the vaccine.

In a YouTube video, Gez Medinger, a science journalist who reports on long COVID, did a survey of 473 long haulers among support groups on Facebook, The Verge reported, around a third of whom saw their symptoms improve after vaccination.

One small study from the UK's University of Bristol, which has not been peer reviewed, looked at giving vaccines to people with long COVID-19 symptoms, per the *Washington Post* report.

The scientists gave the vaccine to 44 COVID long-haulers, and compared their reaction to a group of long-haulers who didn't get the vaccine. They reported that those who had received the vaccine had a "small overall improvement in long COVID symptoms".

However, the authors said that this could be down to the placebo effect. This is just one of a series of puzzling reports surrounding long COVID. On March 3, Kaiser Health News reported that a 15 year-old dancer developed COPD, a disease which is usually seen in older people, after contracting COVID-19 last summer.

As reported by Insider's Aria Bendix, scientists also cannot explain why most of the people who develop long COVID are women, although some scientists think that it could be because women tend to mount stronger immune responses than men.

Recovery clinics for long COVID patients have been opening up, Insider's Sophia Ankel reported. But the condition is still not well understood. The US National Institutes of Health has been given over $US1 ($1) billion by Congress to investigate long COVID.

http://bit.ly/3ly86iI

Palaeontology: Prehistoric armoured dinosaur may have been able to dig

Skeletal remains of an ankylosaurid may indicate that members of this family of dinosaurs were able to dig

Newly excavated skeletal remains of an ankylosaurid -- a large armoured herbivore that lived during the Cretaceous Period -- may indicate that members of this family of dinosaurs were able to dig, according to a study published in *Scientific Reports*. The specimen, known as MPC-D 100/1359, may further our understanding of ankylosaurid behaviour during the Late Cretaceous (84-72 million

years ago).

Yuong-Nam Lee and colleagues excavated the skeletal elements of MPC-D 100/1359 from a deposit of the Baruungoyot Formation in the southern Gobi Desert, Mongolia, where it was discovered in the 1970s. The authors suggest that several anatomical features of MPC-D 100/1359 could indicate that the ankylosaurid was adapted for digging. The bones in its forefeet are arranged in a shallow arc, which could have enabled it to dig soft earth. The fusion of several vertebrae and the decreased number of bones in its hindfeet, compared to other dinosaurs, may have helped anchor MPC-D 100/1359 when digging or moving its tail. The body shape of MPC-D 100/1359, which is wider in the middle and narrower at the front and rear, may have helped its body to remain straight when digging. The authors speculate that MPC-D 100/1359, may have dug the ground in order to reach water, minerals or roots for food and may even have crouched in shallows pits to protect its soft underside from predators. As similar anatomical features have been reported in other ankylosaurids, the findings suggest that the ability to dig may have been common to other members of this family of dinosaurs as well.

A new ankylosaurid skeleton from the Upper Cretaceous Baruungoyot Formation of Mongolia: its implications for ankylosaurid postcranial evolution DOI: 10.1038/s41598-021-83568-4

http://bit.ly/3eW5s51

Bacteria Behind UTIs Make Their Own DNA Building Blocks From Your Urine

Some infectious bacteria have adapted so well to the human bladder, they appear to make their own DNA using chemicals in our urine.

Carly Cassella

The urinary tract is a hard place for most bacteria to survive. That's why urine is often said to be sterile, although that's not actually true. Just like your gut, human urine is home to a community of microbes, known as a microbiota, and while most bacteria that live within it are harmless, sometimes a particular species can tip the scales, causing painful urinary tract infections (UTIs).

Streptococcus agalactiae is a known source of UTIs in some humans, and new research has now revealed how it can survive in such an unfriendly environment.

In a healthy human body, urine should be relatively low in the four nucleobases making up DNA's code, which are broken down into nitrogenous compounds and excreted out.

Sequencing the *S. agalactiae* genome, scientists have now found a key, specialized gene, which allows the bacterium to exploit the presence of other compounds in our urine to produce at least one of these bases - guanine - in order for it to survive.

Similar genes have also recently been found in *Escherichia coli* (E. coli), which is the most common offender of human UTIs.

Usually, in the gut or the blood, *E. coli* and *Streptococcus* scavenge for certain chemicals they need to make DNA, borrowing products like guanine from our own bodies. In the urinary tract, however, these essential building blocks are ultimately broken down into uric acid, which means they are not as easy to find.

It's a tough situation, and it means both *E. coli* and *Streptococcus* must synthesize their own chemical bases if they want to grow and reproduce. "It's basically a survival strategy to colonize the urine, an environment that not many organisms can live in," explains molecular geneticist Matthew Sullivan from Griffith University in Australia. "It seems to be a common strategy among species of bacteria that make up the microbiome of the urine."

In the study, scientists used mice to show how essential this specialized gene, known as guaA, truly is. Collecting *Streptococcus* strains from several individuals, researchers compared a normal *S. agalactiae* infection with a form of the bacterium deficient in guaA.

Microbes that were unable to create their own guanine were unable to colonize the bladder of mice to the same extent. The same thing was found when researchers used synthetic human urine.

This suggests guaA is essential for a *Streptococcus* infection to take hold in the bladder, not just in mice but also in us.

When researchers added extra guanine to the urine, even bacterial strains without the metabolic pathways to create guanine on their own were able to survive and thrive, which suggests this base is an essential limiting factor.

Compared to *E. coli*, *Streptococcus* shows key differences in the way it controls guaA genes, but the outcomes appear quite similar and give us a new avenue for treating UTIs, which have been growing ever more resistant to available antibiotics.

Already, techniques that target guanine synthesis elsewhere in the body have helped beat back other forms of *Streptococcus* bacteria.

While not nearly as common as *E. coli* infections of the bladder, *Streptococcus* causes roughly 160,000 UTIs each year in the US, and these can prove difficult to treat, especially since we don't know a lot about how the infection works.

What's more, because *Streptococcus* UTIs often show up in those who are pregnant, the elderly, and patients with underlying health conditions like diabetes, finding safe and effective treatment options becomes even trickier.

"Research like this gives us new opportunities to develop alternative treatments in a world with increasing antibiotic resistance due to overuse of existing medicines. For example, we could target this pathway in efforts to design new drugs to prevent infection," explains Sullivan. "Overall, the study illuminates the importance of fundamental discoveries that help us perceive how microorganisms interact with humans."

The study was published in the *International Society of Microbial Ecology (ISME) Journal*.

http://bit.ly/3tBHmAM

AI designed to distinguish croissants from crullers and other pastries proves capable of identifying cancerous cells on microscope slides with 99% accuracy

The system was tested in hospitals to see if it can spot cancerous cells

By Stacy Liberatore For Dailymail.com

Artificial intelligence designed to recognize different type of pastries could be a vital tool in the medical world.

BakeryScan, developed by Japan-based Brain Co., scans baked good on a tray with a camera and uploads the official name of each to a system for easy checkout at a bakery – but scientists found it can also identify cancer. A doctor from the Louise Pasteur Center for Medical Research in Kyoto had the system revised to spot cancerous cells on a microscope slide with 99 percent accuracy.

Instead of investigating doughnut holes and bread ridges, the redesigned system, called Cyto-AisCAN, analyzes a urinary cell to identify and measure its nucleus to determine if it is diseased.

BakeryScan, first released in 2013, was designed by computer system engineer Hisashi Kambe who sold the innovation to Brain Co. It is currently used by more than 400 retail shops across Japan and each unit costs $20,000.

BakeryScan works through a camera that is mounted above a backlit checkout tray. Customers place their selections on the tray and then the camera analyzes the bread or pastries, cataloging their size, shape and color to match them with one of up to 100 different types stored in the checkout system.

The cashier confirms the match via a touchscreen display, and then the customer pays – an entire process that takes place in seconds.

Four years after BakeryScan was assisting retail shops, a doctor spotted the technology during a television show and pondered if it could do the same for cancer – he realized cancer cells look similar

to bread when under a microscope, **The New Yorker** reports.

The system uses deep learning for object recognition and instead of differentiating baked goods, the doctor hoped the technology could save lives. Identifying cancer cells to determine whether tumors are benign or malignant can be labor intensive. But having an AI assistant would dramatically speed up the process and lead to earlier diagnoses and more effective treatment for patients.

Brain Co revised BakeryScan for medical purposes to scan small microscope slides instead of puffy pastries. Cyto-AiscAN was then on its way to two major hospitals in Kobe and Kyoto, where doctors tested and trained the system with cancerous cells.

Over time, the AI was able to analyze an entire slide at once and not just each cell individually.

James Somers, the writer of The New York piece, shared: 'The system was apparently working at ninety-nine percent accuracy.'

'I asked Kambe how it worked—did it use deep learning? 'Original way,' he said. Then, with a huge smile, 'Same as bread.'

AI has come a long way from identifying faces to now assisting doctors to help save lives. Last year, a computer algorithm developed by British and US scientists has found AI was able to display a 1.2 percent reduction in the number of false positives and a 2.7 per cent reduction in false negatives.

The breakthrough has been likened to 'a spell-check for writing email' and could reduce the number of 'false negatives' that can lead to life threatening delays in treatment.

The technology has also taken off amid the coronavirus pandemic with many medical experts turning to the system for help.

University of Copenhagen researchers designed software that can tell whether you are likely to die from the virus using health data.

The team used a computer program with health data from 3,944 Danish COVID-19 patients, as well as any underlying conditions.

They then trained it to look for patterns in a patients' prior illness to determine the risk factors and potential outcome from Covid-19 and found that BMI, age and being male were the highest risk factors when it came to the likelihood of dying.

http://bit.ly/2OSNXYQ

5 kids hospitalized with liver failure after drinking ionized 'Real Water'

U.S. health officials are warning people not to use this brand of alkaline water.

By Rachael Rettner - Senior Writer

The FDA is warning people not to use a brand of alkaline water known as "Real Water" after the product was linked with at five cases of serious liver problems. **(Image credit: FDA)**

U.S. health officials are warning people not to use a brand of alkaline water known as "Real Water" after several children in Nevada who drank the water were hospitalized with liver failure, according to news reports.

Such water goes through an ionizing process to raise its pH so that it becomes more basic or alkaline.

This week, the Food and Drug Administration (FDA) announced it is investigating a number of reports of "non-viral hepatitis," or inflammation of the liver not caused by a viral infection, linked with consumption of Real Water.

In November 2020, five infants and children from four different households developed acute liver failure of unknown cause; and six additional people from those households — including three adults and three children — developed less serious symptoms, including vomiting, nausea and loss of appetite, according to a statement from the Southern Nevada Health District.

So far, the only common factor between all these cases was that

they had drunk Real Water, the statement said.

The FDA is investigating the company, which is based in Las Vegas; and in the meantime, the agency is warning consumers, retailers and restaurants not to "drink, cook with, sell or serve" the product, according to the FDA's statement.

The reason for the link between Real Water and the hepatitis cases is unclear; but the Southern Nevada Health District notes that non-viral hepatitis can be caused by exposure to toxins, as well as by autoimmune diseases or drinking too much alcohol.

Real Water is marketed as a "premium, drinking water" that has been "infused with negative ions" and has a pH of 9, according to the company's website.

A water's pH is a measure of how acidic or basic it is, with a range from 0 to 14, according to the U.S. Geological Survey (USGS). Water normally has a neutral pH of 7, and water with a lower pH is considered acidic while water with a higher pH is considered basic, or alkaline. (Specifically, acidic water has more free hydrogen ions, while alkaline water has more free hydroxyl, or OH, ions, according to the USGS.)

Recently, drinking alkaline water with a pH of 8 or 9 has become a health trend, with followers claiming that it can make you age more slowly, maintain a healthy pH in the body and prevent diseases such as cancer, according to Healthline. But there's no evidence that alkaline water has any health benefits over regular water, Healthline reported. (On its website, Real Water says its product "promotes a balanced pH" and can "detoxify," but notes that "these statements have not been evaluated" by the FDA.)

Drinking alkaline water is generally considered safe, although water with high alkaline levels can have an unpleasant taste, according to Healthline. (Acidic water, on the other hand, can be dangerous because it can dissolve metals from pipes and thus become polluted, according to USGS.) The body is generally good at maintaining a pH close to neutral (around 7.4), but too high alkaline levels in the blood can lead to gastrointestinal issues and skin irritation, Healthline reported.

In a statement, Real Water President Brent Jones said, "Our goal is to diligently work with the FDA to achieve a swift resolution," CBS News reported.

"Real Water is asking that all retailers pull the product from the shelf, effective immediately, and hold it in the back rooms or return it to the distributors," Jones' statement said. "Any customer who has purchased Real Water from a retailer is asked to return the product."

One Nevada family has filed a lawsuit against the company alleging that they became sick from the water, CBS News reported.

http://bit.ly/2PaIKeI

New antibiotic clears multi-drug resistant gonorrhea in mice in single dose

Could lead to new treatments for gonorrhea and infections from other bacteria

University Park, Pa. -- A new antibiotic compound clears infection of multi-drug resistant gonorrhea in mice in a single oral dose, according to a new study led by researchers at Penn State and Emory University. The compound targets a molecular pathway found in bacteria but not humans and could lead to new treatments for gonorrhea and infections from other bacteria, such as tuberculosis and MRSA.

The research team, which also includes scientists from the biopharmaceutical company Microbiotix, the Uniformed Services University, and Florida State, published their results in a paper appearing March 19 in the journal *Nature Communications*.

Gonorrhea infects more than 500 thousand people in the United States each year, and several strains of the bacteria that causes the disease, Neisseria gonorrhoeae, are resistant to multiple antibiotics

in use today. For this reason, the Centers for Disease Control and Prevention (CDC) lists multi-drug resistant gonorrhea as one of the five most dangerous urgent threats today.

"Many current antibiotics target the process of translation--when proteins are made based on information in genetic material--within the bacteria," said Ken Keiler, professor of biochemistry and molecular biology at Penn State and an author of the paper. "Over the last decade, we have been investigating a family of compounds that instead inhibit the trans-translation pathway in bacteria, which bacteria use to fix certain kinds of errors during protein synthesis. In this paper, we provide a proof-of-concept that inhibiting the trans-translation pathway can effectively clear multi-drug resistant gonorrhea in animals."

The researchers previously identified a promising trans-translation inhibitor that clears gonorrhea infection in lab cultures but is ineffective in animals because the compound breaks down. In this study, members of the research team at Microbiotix strategically altered the compound to identify which portions of its structure were necessary to inhibit the pathway and which could be changed to improve its stability.

"Our iterative optimization campaign evaluated over 500 versions of the compound to assess their potency, toxicity, and other pharmacological properties," said Zachary Aron, director of chemistry at Microbiotix and an author of the paper. "We determined that the central region of the compound plays a critical role in blocking the trans-translation pathway, however modifications at the periphery could be altered to modulate its pharmacological properties. By altering a functional group to sidestep the primary mechanism of metabolism, we can create versions of the compound that are much more stable in animals."

Members of the research team at the Uniformed Services University then tested one of these modified compounds, MBX-4132, in mice. Their experiments utilized the gonorrhea strain WHO-X, an extremely virulent pathogen that is resistant to almost all approved antibiotics. A single oral dose of the compound completely cleared the infection in 80% of mice within six days, and the bacterial load in the remaining 20% was dramatically reduced.

"Developing a single dose therapy for gonorrhea is incredibly important," said Keiler. "In some cases, bacteria can develop resistance to a drug when additional doses are skipped, for example when a patient starts to feel better and stops taking antibiotics. With a single dose therapy, a patient could complete the treatment during a visit to their health provider."

To better determine how the compound inhibits the trans-translation pathway, members of the research team at Emory University and Florida State University used cryo-electron microscopy (cryo-EM) to produce high-resolution images of the compound as it binds to the bacterial ribosome--the macromolecule where proteins are synthesized.

"A derivative of MBX-4132 binds to a location on the ribosome that is different from all known antibiotic binding sites," said Christine Dunham, associate professor of biochemistry at Emory University and an author of the paper. "The new drug also displaces a region of a ribosomal protein that we think could be important during the normal process of trans-translation. Because trans-translation only occurs in bacteria and not in humans, we hope that the likelihood of the compound affecting protein synthesis in humans is greatly reduced, a hypothesis strongly supported by the safety and selectivity studies performed by Microbiotix."

The research team plans to further optimize the compound before pursuing preclinical trials.

"This type of compound is actually a broad-spectrum inhibitor," said Keiler. "It is effective against most Gram-positive bacteria--including tuberculosis and difficult-to-treat staph infections

(MRSA)--and some Gram-negative bacteria and could be a promising candidate for future treatments. In this study, we lay the groundwork for using this type of compound and demonstrate that inhibiting the trans-translation pathway in bacteria is a viable antibiotic strategy."

In addition to Keiler, Aron and Dunham, the research team includes John Alumasa, Mynthia Cabrera, and Divya Hosangadi at Penn State; Matthew Torhan, Jay Barbor, Steven Cardinale, Steven Kwasny, Lucas Morin, Michelle Butler, Timothy Opperman, and Terry Bowlin at Microbiotix; Atousa Mehrani and Scott Stagg at Florida State; Eric Hoffer and Pooja Srinivas at Emory University; and Kristie Connolly and Ann Jerse at the Uniformed Services University.

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http://bit.ly/3s2t4J3

Don't Be Surprised When Vaccinated People Get Infected

Post-immunization cases, sometimes called "breakthroughs," are very rare and very expected.

Katherine J. Wu

It's hard to know when exactly the first cases appeared. But certainly by January's end, a slow trickle of post-vaccination infections had begun in the United States. They arose in the West, making headlines in Oregon; they sprouted in the Midwest and the South. Some of the latest reports have come out of Florida, Texas, and Hawaii. These breakthrough cases—discovered in people more than two weeks after they received their final COVID-19 shot—will continue to grow in number, everywhere. And that's absolutely no cause for concern.

Breakthrough infections, which occur when fully vaccinated people are infected by the pathogen that their shots were designed to protect against, are an entirely expected part of any vaccination process. They're the data points that keep vaccines from reaching 100 percent efficacy in trials; they're simple proof that no inoculation is a perfect preventative. And so far, the ones found after COVID-19 vaccination seem to be unextraordinary.

Since mid-December, when the rollout of the newly authorized vaccines began, nearly 40 million Americans have received the jabs they need for full immunization. A vanishingly small percentage of those people have gone on to test positive for the coronavirus. The post-shot sicknesses documented so far seem to be mostly mild, reaffirming the idea that inoculations are powerful weapons against serious disease, hospitalization, and death. This smattering of cases is a hazy portent of our future: Coronavirus infections will continue to occur, even as the masses join the ranks of the inoculated. The goal of vaccination isn't eradication, but a détente in which humans and viruses coexist, with the risk of disease at a tolerable low.

When breakthrough cases do arise, it's not always clear why. The trio of vaccines now circulating in the United States were all designed around the original coronavirus variant, and seem to be a bit less effective against some newer versions of the virus. These troublesome variants have yet to render any of our current vaccines obsolete. But "the more variants there are, the more concern you have for breakthrough cases," Saad Omer, a vaccine expert at Yale, told me. The circumstances of exposure to *any* version of the coronavirus will also make a difference. If vaccinated people are spending time with groups of unvaccinated people in places where the virus is running rampant, that still raises their chance of getting sick. Large doses of the virus can overwhelm the sturdiest of immune defenses, if given the chance.

The human side of the equation matters, too. Immunity is not a monolith, and the degree of defense roused by an infection or a vaccine will differ from person to person, even between identical twins. Some people might have underlying conditions that hamstring their immune system's response to vaccination; others might simply, by chance, churn out fewer or less potent antibodies and T cells that can nip a coronavirus infection in the bud.

The effects of vaccination are best considered along a spectrum, says Ali Ellebedy, an immunologist at Washington University in St. Louis. An ideal response to vaccination might create an arsenal of immune molecules and cells that can instantaneously squelch the virus, leaving no time for symptoms to appear. But sometimes that front line of fighters is relatively sparse. Should the virus make it through, "it becomes a race [against] time," Ellebedy told me. The pathogen rushes to copy itself, and the immune system recruits more defenders. The longer the tussle drags on, the more likely the disease is to manifest.

The range of vaccine responses "isn't a variation of two- to threefold; it's thousands," Ellebedy told me. "Being vaccinated doesn't mean you are immune. It means you have a better *chance* of protection."

For these reasons and more, Viviana Simon, a virologist at the Icahn School of Medicine at Mount Sinai, in New York, dislikes the term *breakthrough case*, which evokes a barrier walling humans off from disease. "It's very misleading," she told me. "It's like the virus 'punches' through our defenses."

Vaccination is actually more like a single variable in a dynamic playing field—a *layer* of protection, like an umbrella, that might guard better in some situations than others. It could keep a lucky traveler relatively dry in a light drizzle, but in a windy maelstrom that's whipping heavy droplets every which way, another person might be overwhelmed. And under many circumstances, vaccines are still best paired with safeguards such as masks and distancing—just as rain boots and jackets would help buffer someone in a storm.

In some ways, the shots' staggering success in trials—where breakthrough cases were *also* observed, causing appropriately minimal stir—may have papered over the inevitability of post-vaccination infections in more natural settings. "The vaccines exceeded expectations," Luciana Borio, a former acting chief scientist at the FDA, told me. Now, as we exit what Borio calls the "honeymoon phase" of our relationship with the jabs, we need to temper our enthusiasm with the right amount of realism, especially as more data on the shots' strength and longevity accumulate. Even excellent vaccines aren't foolproof, and they shouldn't be criticized when they're not. "We can't expect it's going to be perfect, on day one, always," Borio said.

Breakthrough cases also include asymptomatic infections, according to the CDC's current definition—which is different from the criteria on which the vaccines were originally judged. In clinical trials, the three vaccines cleared for emergency use in the United States were evaluated for their ability to prevent *symptomatic* cases of COVID-19, which they each do to a remarkably high extent. The Moderna and Pfizer-BioNTech jabs reduce, on a population scale, the risk of disease by about 95 percent; Johnson & Johnson's clocked in at 72 percent among Americans.

The numbers for asymptomatic infections are still crystallizing, but they're likely to be lower. Purging a virus before sickness sets in is a higher bar for the immune system to clear. "The trick is to distinguish between infection and disease," Simon told me. "Whenever someone tests positive, the real question is, are they sick, and how sick are they? That's a big difference."

Efficacy, a figure specific to clinical trials, also doesn't always translate perfectly to the messiness of the real world, where there's immense variability in how, when, where, by whom, and to whom shots are administered. The vaccine's performance under these conditions is tracked by a separate measure, called effectiveness. Studies rigorously examining vaccine *effectiveness* are challenging, but early data suggest that the Pfizer-BioNTech and Moderna shots are living up to their initial hype.

The number of post-vaccination infections is also contingent on "the ongoing transmission situation," Omer told me. "It depends on

how much people are mixing." A vaccine with a recorded efficacy of 95 percent, for example, doesn't give everyone who's vaccinated a 5 percent chance of getting sick. Not all of those people will even encounter the virus. The key is how vaccination changes the outcome for those who *are* meaningfully exposed: Among 100 individuals who might have fallen ill without the vaccine, just five symptomatic cases might appear.

A team at the CDC is tracking breakthroughs and will soon start reporting case counts, as well as any patterns related to where, or in whom, these infections are occurring, Martha Sharan, a CDC spokesperson, told me. Details like those matter. They can help experts figure out why post-vaccination infections happen, and how they might be stopped. "The reassuring part is, these cases will not go unnoticed," Omer told me.

Most of the time, vaccines are far more likely to offer some help than none. Serious disease, hospitalization, and even death will still occur, as will less well-studied outcomes, such as the long-term symptoms that often arise from less severe disease. But should post-vaccination infections climb to unexpectedly high rates, backup plans will quickly kick into gear. Some shot recipients might get second or third shots to bolster their immune response; others might be administered a tweaked vaccine recipe to account for a new viral variant.

There's something a touch counterintuitive about breakthrough cases: The more people we vaccinate, the more such cases there will be, in absolute numbers. But the rate at which they appear will also decline, as rising levels of population immunity cut the conduits that the virus needs to travel. People with lackluster responses to vaccines—as well as those who can't get their jabs—will receive protection from the many millions in whom the shots *did* work. In a crowd of people holding umbrellas, even those who are empty-handed will stay more dry.

https://go.nature.com/2QqlrOK

Pool patents to get COVID vaccines and drugs to all

We call on pharmaceutical companies to contribute to a pool of patents set up by the World Health Organization (WHO).

Etienne Billette de Villemeur, Vianney Dequiedt & Bruno Versaevel

That will speed up the manufacture of generic, affordable COVID-19 vaccines and treatments while protecting firms' incentives to invest in future research. The WHO's COVID-19 Technology Access Pool has so far received no contributions from industry.

Asking governments in rich nations to donate vaccines to lower-income countries (see G. Yamey *Nature* **590**, 529; 2021) will not hasten manufacture. India and South Africa have proposed suspending patents related to COVID-19 products, but companies contend that this could dent drug development.

The practice of pooling patented technologies for the production of medicines (see *Nature* **581**, 240; 2020) already occurs for HIV, hepatitis C and tuberculosis treatments. Fees are typically lower when licences are negotiated as a bundle with generics producers, implying increased volume (J. Lerner and J. Tirole *Innov. Policy Econ.* **8**, 157–186; 2007). Yet firms can anticipate extra revenue from participation in a voluntary pool, and thus be more willing to maintain innovation and share know-how than with compulsory licensing.

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http://bit.ly/2PeL2cU

Ancient Native Americans were among the world's first coppersmiths

New study concludes that what is known as the Old Copper Culture emerged, then faded, far earlier than once thought

By David Malakoff

About 8500 years ago, hunter-gatherers living beside Eagle Lake in Wisconsin hammered out a conical, 10-centimeter-long projectile

point made of pure copper. The finely crafted point, used to hunt big game, highlights a New World technological triumph—and a puzzle. A new study of that artifact and other traces of prehistoric mining concludes that what is known as the Old Copper Culture emerged, then mysteriously faded, far earlier than once thought.

The dates show that early Native Americans were among the first people in the world to mine metal and fashion it into tools. They also suggest a regional climate shift might help explain why, after thousands of years, the pioneering metallurgists abruptly stopped making most copper tools and largely returned to stone and bone implements.

Archaeologist Michelle Bebber of Kent State University, Kent, made these replicas of copper arrowheads and knives crafted by people of North America's Old Copper Culture. **Michelle Bebber/Kent State University Experimental Archaeology Lab**

Earth's largest and purest copper deposits are found around North America's Great Lakes. At some point, Native Americans learned to harvest the ore and heat, hammer, and grind it into tools. They left behind thousands of mines and countless copper artifacts, including lethal projectile points, hefty knives and axes, and petite fish hooks and awls. Today, it's not uncommon to meet residents of the region "who have buckets of copper artifacts [that they've found] tucked away in their basements," says David Pompeani, a geologist at Kansas State University, Manhattan, who studies ancient mining.

When researchers began to date the artifacts and mines, they saw a perplexing pattern: The dates suggested the people of the Old Copper Culture began to produce metal tools about 6000 years ago and then, for reasons that weren't clear, mostly abandoned copper implements about 3000 years ago. After that, early Native Americans used copper mostly for smaller, less utilitarian items associated with adornment, such as beads and bracelets. "The history is just so peculiar," in part because many other ancient cultures didn't abandon metal tools once they learned how to make them, Pompeani says.

About 10 years ago, Pompeani began doctoral research that cast doubt on the Old Copper timeline. He extracted sediment cores from lakes adjacent to prehistoric mines on Michigan's Keweenaw Peninsula and Isle Royale and measured trace metals in the cores, including lead and titanium, that had been released by processing the ore. The analyses showed copper mining began about 9500 years ago in some areas—some 3500 years earlier than once thought. It also ended earlier, about 5400 years ago, Pompeani reported in *The Holocene* in 2015.

Now, a team led by Pompeani presents new evidence for the revised timeline. The researchers used modern methods to reanalyze 53 radiocarbon dates—including eight newly collected dates—associated with the Old Copper Culture. Some came from wood or cordage still attached to spearpoints; others came from charcoal, wood, or bone found at mines and human burials. The oldest reliably dated artifact turned out to be the 8500-year-old projectile point found in Wisconsin.

This month in *Radiocarbon*, the team reports that the most reliable dates, combined with the sediment data, indicate the Old Copper Culture emerged at least 9500 years ago and peaked between 7000 and 5000 years ago. That makes it at least as old, and perhaps older, than copper-working cultures documented in the Middle East, where archaeologists have documented a copper pendant believed to be 8700 years old.

The older window for Old Copper's peak doesn't surprise archaeologist Michelle Bebber of Kent State University, Kent, who

has studied the culture. The dates confirm "that hunter-gatherers [were] highly innovative," she says, and willing to "regularly experiment with novel materials."

But why did the ancient copper experiment abruptly end? Bebber's work replicating Old Copper–style arrowheads, knives, and awls suggests they weren't necessarily superior to the alternatives, especially after factoring in the time and effort required to produce metal implements. In controlled laboratory tests, such as shooting arrows into clay blocks that simulate meat, she found that stone and bone implements were mostly just as effective as copper. That might be because Great Lakes copper is unusually pure, which makes it soft, unlike harder natural copper alloys found elsewhere in the world, she says. Only copper awls proved superior to bone hole punchers.

Pompeani has identified another potential contributor to Old Copper's fade about 5000 years ago. Sediment cores, tree ring data, and other evidence suggest a sustained dry period struck the region around that time, he says. That could have fueled social and ecological disruptions that made it hard to devote time and resources to making copper tools. Over time, copper may have become something of a luxury item, used to signal social status.

Copper awls, however, bucked this trend: They required relatively little ore to make, Bebber notes, and the people of the Great Lakes continued to use them for thousands of years.

http://bit.ly/3s9KzY0

Titan's largest crater might be the perfect cradle for life

Surface coated in organic hydrocarbons, and icy crust thought to cover a watery ocean

By Jonathan O'Callaghan

Saturn's frigid moon Titan has long intrigued scientists searching for life in the Solar System. Its surface is coated in organic hydrocarbons, and its icy crust is thought to cover a watery ocean. An asteroid or comet slamming into the moon could theoretically mix these two ingredients, according to a new study, with the resulting impact craters providing an ideal place for life to get started.

The idea is "very exciting," says Léa Bonnefoy, a planetary scientist and Titan expert at the University of Paris. "If you have a lot of liquid water creating a temporary warm pool on the surface, then you can have conditions that would be favorable for life," she says. And, "If you have organic material cycling from the surface into the ocean, then that makes the ocean a bit more habitable."

Scientists have believed an ocean sits about 100 kilometers below Titan's crust ever since 2012, when NASA's Cassini mission measured sight variations in the moon's tides. Alvaro Penteado Crósta, a planetary geologist at the University of Campinas, knew the moon was pocked with many large impact craters. He wondered whether any of the impacts were big enough to pierce the crust and churn up the surface's organic material with the water below. That may have produced "a primordial soup that you would need for life to develop," Penteado Crósta says.

To find out, he and his colleagues modeled the impact for the moon's largest crater, 425-kilometer-wide Menrva, thought to have formed 1 billion years ago. The model suggested the crater resulted from a 34-kilometer-wide space rock hitting the surface at 7 kilometers per second.

The heat of the impact would have created a lake in the crater, according to the model, which the team presented this week at the Lunar and Planetary Science Conference. The lake would likely only have existed for 1 million years before freezing over in Titan's frosty temperatures. But Penteado Crósta says this may have been enough time for microbes to evolve, taking advantage of liquid water, organic molecules, and heat from the impact. "That's pretty

good for bacteria."

Although the team's research focused on Menrva, Penteado Crósta says it is possible that smaller impacts were sufficient to break through Titan's ice shell, perhaps even at Selk—a 90-kilometer-wide crater about 5000 kilometers away. Selk is thought to be much younger than Menrva, perhaps just a few hundred million years old, which would mean any evidence of life there would be fresher. "Selk may have more chance to have some sort of fossilized bacteria preserved in the ice," Penteado Crósta says.

Selk is the planned landing site for NASA's Dragonfly mission, a $1 billion autonomous and nuclear-powered drone set to launch in 2027 and arrive on Titan 2036. If the impact did break the ice crust here, the mission could find out.

But Elizabeth Turtle, principal investigator for the Dragonfly mission at the Johns Hopkins University Applied Physics Laboratory, isn't so sure it did. "There isn't strong evidence to suggest you actually had puncturing," she says.

Still, Dragonfly could visit other craters in an extended mission. And although Menrva might be too distant, it could be an intriguing landing site in future, Penteado Crósta says.

http://bit.ly/3s3UYo1

Scientist behind COVID-19 mRNA vaccine says her team's next target is cancer

'We have several different cancer vaccines based on mRNA'

The scientist who won the race to deliver the first widely used coronavirus vaccine says people can rest assured the shots are safe, and that the technology behind it will soon be used to fight another global scourge — cancer.

Ozlem Tureci, who founded the German company BioNTech with her husband, Ugur Sahin, was working on a way to harness the body's immune system to tackle tumours when they learned last year of an unknown virus infecting people in China.

Over breakfast, the couple decided to apply the technology they'd been researching for two decades to the new threat.

Britain authorized BioNTech's mRNA vaccine for use in December, followed a week later by Canada. Dozens of other countries, including the U.S., have followed suit and tens of millions of people worldwide have since received the shot developed together with U.S. pharmaceutical giant Pfizer.

"It pays off to make bold decisions and to trust that if you have an extraordinary team, you will be able to solve any problem and obstacle which comes your way in real time," Tureci told The Associated Press in an interview.

Ozlem Tureci, co-founder of the Mainz, Germany-based coronavirus vaccine developer BioNTech, says her research team will be turning their focus back toward cancer. **(Bernd von Jutrczenka/dpa/The Associated Press)**

Among the biggest challenges for the small, Mainz-based company were how to conduct large-scale clinical trials across different regions and how to scale up the manufacturing process to meet global demand.

Along with Pfizer, the company enlisted the help of Fosun Pharma in China "to get assets, capabilities and geographical footprint on board, which we did not have," said Tureci.

Co-operation and collaboration

Among the lessons she and her colleagues learned was "how important co-operation and collaboration is internationally."

Tureci, who was born in Germany to Turkish immigrants, said the company reached out to medical oversight bodies from the start, to ensure that the new type of vaccine would pass the rigorous scrutiny of regulators.

"The process of getting a medicine or a vaccine approved is one where many questions are asked, many experts are involved and

there is external peer review of all the data and scientific discourse," she said.

Amid a scare in Europe this week over the coronavirus shot made by British-Swedish rival AstraZeneca, Tureci dismissed the idea that any corners were cut by those racing to develop a vaccine.

"There is a very rigid process in place and the process does not stop after a vaccine has been approved," she said. "It is, in fact, continuing now all around the world, where regulators have used reporting systems to screen and to assess any observations made with our or other vaccines."

Tureci and her colleagues have all received the BioNTech shot themselves, she told the AP. "Yes, we have been vaccinated."

Aim to develop new tool in fight against cancer

As BioNTech's profile has grown during the pandemic, so has its value, adding much-needed funds the company will be able to use to pursue its original goal of developing a new tool against cancer.

The vaccine made by BioNTech-Pfizer and U.S. rival Moderna uses messenger RNA, or mRNA, to carry instructions into the human body for making proteins that prime it to attack a specific virus. The same principle can be applied to get the immune system to take on tumours. "We have several different cancer vaccines based on mRNA," said Tureci.

Asked when such a therapy might be available, Tureci said "that's very difficult to predict in innovative development. But we expect that within only a couple of years, we will also have our vaccines [against] cancer at a place where we can offer them to people."

For now, Tureci and Sahin are trying to ensure the vaccines governments have ordered are delivered and that the shots respond effectively to any new mutation in the virus.

On Friday, the couple were taking time out of their schedule to receive Germany's highest award, the Order of Merit, from President Frank-Walter Steinmeier. German Chancellor Angela Merkel, a trained scientist herself, was to attend the ceremony.

"It's indeed an honour," Tureci said of the award. "Both my husband and I are touched."

But she insisted developing the vaccine was the work of many.

"It's about the effort of many, our team at BioNTech, all the partners who were involved, also governments, regulatory authorities, which worked together with a sense of urgency," she said. "The way we see it, this is an acknowledgement of this effort and also a celebration of science."

http://bit.ly/3tG2Cp0

White button mushrooms could slow progression of prostate cancer

Mouse study suggests mushrooms may suppress androgen receptor activity

Washington--The chemicals present in white button mushrooms may slow the progression of prostate cancer, according to a mouse study presented virtually at ENDO 2021, the Endocrine Society's annual meeting.

"Androgens, a type of male sex hormone, promote the growth of prostate cancer cells by binding to and activating the androgen receptor, a protein that is expressed in prostate cells," said lead researcher Xiaoqiang Wang, M.D., Ph.D., M.B. (A.S.C.P.), of the Beckman Research Institute of City of Hope, a comprehensive cancer center in Duarte, Calif. "White button mushrooms appear to suppress the activity of the androgen receptor."

City of Hope's Shiuan Chen, Ph.D., the principal investigator of this project, previously conducted a phase one clinical trial of white button mushroom powder in patients with recurrent prostate cancer, which indicated that the mushrooms reduced levels of prostate-specific antigen (PSA) in the blood, with minimal side effects. Heightened blood levels of PSA in men may indicate the existence of prostate tumors.

The new study aimed to understand the mechanism behind this finding. The researchers studied the mushroom extract's effect on prostate cancer cells that were sensitive to androgen. They also studied the extract's effect on mice implanted with human prostate tumors, which creates an animal model whose results would be more reliable as the research is translated to human clinical trials.

The researchers found that in prostate cancer cells, white button mushroom extract suppressed androgen receptor activity. They also found that in mice treated with white button mushroom extract for six days, prostate tumor growth was significantly suppressed, and levels of PSA decreased.

"We found that white button mushrooms contain chemicals that can block the activity of the androgen receptor in mouse models, indicating this fungus can reduce PSA levels," Wang said. "While more research is needed, it's possible that white button mushrooms could one day contribute to the prevention and treatment of prostate cancer."

http://bit.ly/3vMqMjn

We Finally Know How Sperm 'Remember' And Pass on Non-DNA-Coded Traits to Embryos

'Memories' of environmental effects are passed on from dads to offspring, despite not being coded for in DNA

Tessa Koumoundouros

Studies in mammals have shown that the 'memories' of various environmental effects – such as diet, weight, and stress – are being passed on from dads to offspring, despite these states not being coded for in the DNA sequences carried by sperm. Now, we have a new explanation for how it's possible.

The story has much to do with epigenetics. Molecules that attach themselves to DNA can act like on-off switches that control which sections of DNA get used – but until now we haven't known which of these molecules can carry the settings marked by a father's life experiences, to be incorporated into an embryo via sperm.

"The big breakthrough with this study is that it has identified a non-DNA-based means by which sperm remember a father's environment (diet) and transmit that information to the embryo," said McGill University epigeneticist Sarah Kimmins.

Using mice, epigeneticist Ariane Lismer and colleagues were able to demonstrate that the effects of a folate-deficient diet could be passed on by altering histone molecules in sperm. Simply put, histones are really basic proteins that DNA winds around for tangle-free storage.

In mammals, when male bodies build sperm, they throw out most of the histone spools, to allow for tighter packing.

But a small percentage still remains (1 percent in mice and 15 percent in humans), providing scaffolding for DNA in regions specific to sperm creation and function, metabolism, and embryo development – to allow the cellular mechanisms to make use of these DNA instructions.

Chemical modification of these histones – the most common form being methylation – is what allows or prevents the DNA to be 'read' so that it can be transcribed into protein products. Poor diet can cause these histones to change their methylation status.

This is why we hear about the importance of folate for women during pregnancy: A mother's folate helps stabilize DNA methylation in their young.

By feeding male mice a folate-deficient diet from the time they were weaned, the researchers were able to track the changes to histones from the male's sperm and in the resulting embryos. And indeed, sperm histone changes were also present in the developing embryo.

"No one has been able to track how those heritable environmental signatures are transmitted from the sperm to the embryo before," said Lismer.

The team also discovered these effects could be cumulative and lead to an increase in the severity of birth defects.

Interestingly, the birth defects seen in the mice, including underdevelopment at birth and spinal abnormalities, are well documented in folate-deficient human populations.

The researchers hope that expanding our knowledge of inheritance mechanisms will reveal new ways to treat and prevent such conditions. But there is a lot more to work out before then.

"Our next steps will be to determine if these harmful changes induced in the sperm proteins (histones) can be repaired. We have exciting new work that suggests that this is indeed the case," said Kimmins.

This research was published in *Developmental Cell*.