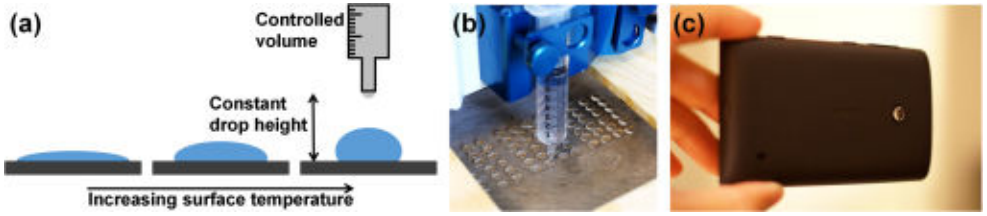
http://www.eurekalert.org/pub_releases/2015-05/uoh-urc050415.php

UH researchers create lens to turn smartphone into microscope

Researchers at the University of Houston have created an optical lens that can be placed on an inexpensive smartphone to magnify images by a magnitude of 120, all for just 3 cents a lens.

HOUSTON - Wei-Chuan Shih, assistant professor of electrical and computer engineering at UH, said the lens can work as a microscope, and the cost and ease of using it - it attaches directly to a smartphone camera lens, without the use of any additional device - make it ideal for use with younger students in the classroom. It also could have clinical applications, allowing small or isolated clinics to share images with specialists located elsewhere, he said.



Lens could give schools, clinics low-cost alternative to conventional equipment

a) Changing the temperature of the preheated surface modifies the shape of a cured lens. b) The inkjet print head printing droplet lenses on a heated surface, and c) The lens can be attached to a smartphone for microscopy applications. **University of Houston**

In a paper published in the Journal of Biomedical Optics, Shih and three graduate students describe how they produced the lenses and examine the image quality. Yu-Lung Sung, a doctoral candidate, served as first author; others involved in the study include Jenn Jeang, who will start graduate school at Liberty University in Virginia this fall, and Chia-Hsiung Lee, a former graduate student at UH now working in the technology industry in Taiwan.

The lens is made of polydimethylsiloxane (PDMS), a polymer with the consistency of honey, dropped precisely on a preheated surface to cure. Lens curvature - and therefore, magnification - depends on how long and at what temperature the PDMS is heated, Sung said. The resulting lenses are flexible, similar to a soft contact lens, although they are thicker and slightly smaller. "Our lens can transform a smartphone camera into a microscope by simply attaching the lens without any supporting attachments or mechanism," the researchers wrote. "The strong, yet non-permanent adhesion between PDMS and glass allows the lens to be easily detached after use. An imaging resolution of 1 (micrometer) with an optical magnification of 120X has been achieved."

Conventional lenses are produced by mechanical polishing or injection molding of materials such as glass or plastics. Liquid lenses are available, too, but those that aren't cured require special housing to remain stable. Other types of liquid lenses require an additional device to adhere to the smartphone. This lens attaches directly to the phone's camera lens and remains attached, Sung said; it is reusable.

For the study, researchers captured images of a human skin-hair follicle histological slide with both the smartphone-PDMS system and an Olympus IX-70 microscope. At a magnification of 120, the smartphone lens was comparable to the Olympus microscope at a magnification of 100, they said, and software-based digital magnification could enhance it further.

With his primary appointment in the Department of Electrical and Computer Engineering, Shih is also affiliated with the Department of Biomedical Engineering and the Department of Chemistry. His interdisciplinary team is focused on nanobiophotonics and nanofluidics, pursuing discoveries in imaging and sensing, including work to improve medical diagnostics and environmental safety. Sung said he was using PDMS to build microfluidic devices and as he worked with a lab hotplate, realized the material cured on contact with the heated surface. Intrigued, he decided to try making a lens.

"I put it on my phone, and it turns out it works," he said. Sung uses a Nokia Lumia 520, prompting him to say the resulting microscope came from "a $20 phone and a 1 cent lens." That 1 cent covers the cost of the material; he and Shih estimate that it will cost about 3 cents to manufacture the lenses in bulk. A conventional, research quality microscope, by comparison, can cost $10,000. "A microscope is much more versatile, but of course, much more expensive," Sung said.

His first thought on an application for the lens was educational -- it would be a cheap and convenient way for younger students to do field studies or classroom work. Because the lens attaches to a smartphone, it's easy to share images by email or text, he said. And because the lenses are so inexpensive, it wouldn't be a disaster if a lens was lost or broken. "Nearly everyone has a smartphone," Sung said. "Instead of using a $30 or $50 attachment that students might use only once or twice, they could use this."

For now, researchers are producing the lenses by hand, using a hand-built device that functions similarly to an inkjet printer. But producing the lenses in bulk will require funding, and the graduate students launched a crowdfunding campaign through Indiegogo, hoping to raise $12,000 for the equipment. They've raised $3,000 so far. Undeterred, they have shared the lenses with the Ministry of Education in Taiwan and with teachHOUSTON, a math and science teacher preparation program at UH. "I think it will be fun," Shih said. "We could invite

science teachers to watch what we do." *To read the paper, visit:* *http://biomedicaloptics.spiedigitallibrary.org/article.aspx?articleid=2279353&resultClick=1*

http://www.eurekalert.org/pub_releases/2015-05/miot-id043015.php

India drift

MIT researchers explain mystery of India's rapid move toward Eurasia 80 million years ago

In the history of continental drift, India has been a mysterious record-holder.

More than 140 million years ago, India was part of an immense supercontinent called Gondwana, which covered much of the Southern Hemisphere. Around 120 million years ago, what is now India broke off and started slowly migrating north, at about 5 centimeters per year. Then, about 80 million years ago, the continent suddenly sped up, racing north at about 15 centimeters per year -- about twice as fast as the fastest modern tectonic drift. The continent collided with Eurasia about 50 million years ago, giving rise to the Himalayas.

For years, scientists have struggled to explain how India could have drifted northward so quickly. Now geologists at MIT have offered up an answer: India was pulled northward by the combination of two subduction zones -- regions in the Earth's mantle where the edge of one tectonic plate sinks under another plate. As one plate sinks, it pulls along any connected landmasses. The geologists reasoned that two such sinking plates would provide twice the pulling power, doubling India's drift velocity.

The team found relics of what may have been two subduction zones by sampling and dating rocks from the Himalayan region. They then developed a model for a double subduction system, and determined that India's ancient drift velocity could have depended on two factors within the system: the width of the subducting plates, and the distance between them. If the plates are relatively narrow and far apart, they would likely cause India to drift at a faster rate.

In this artist's rendering, the left image shows what Earth looked like more than 140 million years ago, when India was part of an immense supercontinent called Gondwana. The right image shows Earth today. **iStock (edited by MIT News)**

The group incorporated the measurements they obtained from the Himalayas into their new model, and found that a double subduction system may indeed have driven India to drift at high speed toward Eurasia some 80 million years ago.

"In earth science, it's hard to be completely sure of anything," says Leigh Royden, a professor of geology and geophysics in MIT's Department of Earth, Atmospheric and Planetary Sciences. "But there are so many pieces of evidence that all fit together here that we're pretty convinced."

Royden and colleagues including Oliver Jagoutz, an associate professor of earth, atmospheric, and planetary sciences at MIT, and others at the University of Southern California have published their results this week in the journal Nature Geoscience.

What drives drift?

Based on the geologic record, India's migration appears to have started about 120 million years ago, when Gondwana began to break apart. India was sent adrift across what was then the Tethys Ocean -- an immense body of water that separated Gondwana from Eurasia. India drifted along at an unremarkable 40 millimeters per year until about 80 million years ago, when it suddenly sped up to 150 millimeters per year. India kept up this velocity for another 30 million years before hitting the brakes -- just when the continent collided with Eurasia.

"When you look at simulations of Gondwana breaking up, the plates kind of start to move, and then India comes slowly off of Antarctica, and suddenly it just zooms across -- it's very dramatic," Royden says.

In 2011, scientists believed they had identified the driving force behind India's fast drift: a plume of magma that welled up from the Earth's mantle. According to their hypothesis, the plume created a volcanic jet of material underneath India, which the subcontinent could effectively "surf" at high speed.

However, when others modeled this scenario, they found that any volcanic activity would have lasted, at most, for 5 million years -- not nearly enough time to account for India's 30 million years of high-velocity drift.

Squeezing honey

Instead, Royden and Jagoutz believe that India's fast drift may be explained by the subduction of two plates: the tectonic plate carrying India and a second plate in the middle of the Tethys Ocean.

In 2013, the team, along with 30 students, trekked through the Himalayas, where they collected rocks and took paleomagnetic measurements to determine where the rocks originally formed. From the data, the researchers determined that about 80 million years ago, an arc of volcanoes formed near the equator, which was then in the middle of the Tethys Ocean.

A volcanic arc is typically a sign of a subduction zone, and the group identified a second volcanic arc south of the first, near where India first began to break away from Gondwana. The data suggested that there may have been two subducting plates: a northern oceanic plate, and a southern tectonic plate that carried India.

Back at MIT, Royden and Jagoutz developed a model of double subduction involving a northern and a southern plate. They calculated how the plates would move as each subducted, or sank into the Earth's mantle. As plates sink, they squeeze material out between their edges. The more material that can be squeezed out, the faster a plate can migrate. The team calculated that plates that are relatively narrow and far apart can squeeze more material out, resulting in faster drift.

"Imagine it's easier to squeeze honey through a wide tube, versus a very narrow tube," Royden says. "It's exactly the same phenomenon."

Royden and Jagoutz's measurements from the Himalayas showed that the northern oceanic plate remained extremely wide, spanning nearly one-third of the Earth's circumference. However, the southern plate carrying India underwent a radical change: About 80 million years ago, a collision with Africa cut that plate down to 3,000 kilometers -- right around the time India started to speed up.

The team believes the diminished plate allowed more material to escape between the two plates. Based on the dimensions of the plates, the researchers calculated that India would have sped up from 50 to 150 millimeters per year. While others have calculated similar rates for India's drift, this is the first evidence that double subduction acted as the continent's driving force.

"It's a lucky coincidence of events," says Jagoutz, who sees the results as a starting point for a new set of questions. "There were a lot of changes going on in that time period, including climate, that may be explained by this phenomenon. So we have a few ideas we want to look at in the future."

http://www.eurekalert.org/pub_releases/2015-05/sp-hut050115.php

Hot under the collar: The untold dangers firefighters face in the line of duty

What do you think is the biggest cause of death for firefighters on duty?
Well if your first thought was burns or smoke inhalation you'd be wrong!

According to research published in the June edition of Vascular Medicine "since 1977, sudden cardiac death has accounted for the largest share of on-duty deaths among firefighters - surpassing burns, trauma, asphyxiation and smoke inhalation."

Although the number of deaths amongst firefighters is declining, cardiac death still counts for 42% of deaths in on-duty firefighters over the past 5 years. A potential untold problem that could be putting additional strain on firefighter's hearts is heat stress as firefighters wearing heavy insulating protective gear are often required to partake in intense exercise whilst fighting fires. Two studies to be published in Vascular Medicine have sought to examine the impact of heat stress on the heart and in blood vessels, looking at how much impact firefighters protective uniforms have on the heart and the effect of aspirin on blood vessel function.

Dr. Hamburg, Associate Editor of Vascular Medicine, stated that:

"These two studies demonstrate that heat stress may be a key factor in contributing to cardiovascular risk in firefighters though its adverse effects on blood vessel function".

'Dr. Mobin Malik and Dr. Michael Widlansky of the Medical College of Wisconsin commented in the accompanying editorial to the studies that:

"These two investigative groups should be commended for their efforts in further advancing our understanding of the impact of heat stress on vasculature and pointing us in the direction of potential mechanisms and therapies."

The full articles will be published in the June issue. The two articles, ahead of print, can be accessed here and here and the accompanying editorial can be read here. To receive full copies of the articles please email PR Assistant Tiffany Medina (tiffany.medina@sagepub.co.uk)

http://www.eurekalert.org/pub_releases/2015-05/du-srt042915.php

Scientists reconcile three unrelated theories of schizophrenia

Mouse model will help scientists parse brain-based findings

DURHAM, N.C. - A new Duke University study in mice links three previous and, until now, apparently unrelated hypotheses about the causes of schizophrenia, a debilitating mental disorder appearing in late adolescence that affects how people think, act and perceive reality.

The brains of people with the schizophrenia show various abnormalities, including faulty neural connections or an imbalance of certain brain chemicals. However, it has been unclear whether such brain-based observations could be related to one another or could describe different types of schizophrenia.

Published May 4, 2015, in Nature Neuroscience, the new findings may eventually lead to treatment strategies targeted for the underlying causes of schizophrenia and related disorders, said the study's corresponding author Scott Soderling, an associate professor of cell biology and neurobiology in the Duke School of Medicine.

Schizophrenia is complex at every level, from genes to brain to behavior, said Soderling, who is also a member of the Duke Institute for Brain Sciences. People with the illness show a wide range of symptoms that vary in severity. Genome-

wide association studies have implicated hundreds of mutations that might confer risk.

In 2013, Soderling's group selected one of those gene candidates, Arp2/3, based on its importance in controlling the formation of synapses -- the links between neurons -- and its association with multiple neuropsychiatric disorders. They deleted the gene from the excitatory neurons in the forebrains of mice.

To their surprise, mice lacking Arp2/3 showed several behaviors reminiscent of schizophrenia. And just as in the human disease, the mice seemed to worsen over time. Antipsychotic medications, a mainstay of treatment for schizophrenia, alleviated some of the animals' symptoms.

In the new study, Soderling, postdoctoral researcher Il Hwan Kim, and their team characterized three brain abnormalities in the Arp2/3 mice that also appear in people with schizophrenia.

One is the 'spine pruning theory,' supported by the observation that the frontal brain regions of people with schizophrenia have fewer dendritic spines, the tentacles on the receiving ends of neurons that process signals from other cells.

These mice, by nature of their genetic deletion, lose dendritic spines as they age, the group confirmed.

A second observation in people with schizophrenia is hyperactive neurons, which are also in the front of the brain, a region that is involved in planning and decision-making.

Surprisingly, the study found the mice missing Arp2/3 also have this feature. At first, it seemed that a brain area with fewer spines couldn't also be hyperactive. However, using high-resolution microscopy, the team found that neurons were rewired to bypass the dendritic spine, which acts as an electrical filter. Missing this filter can make the cells overactive, Soderling said.

A third theory, the 'dopamine hypothesis,' points to elevated levels of the brain chemical dopamine. Support for the theory comes from the observation that antipsychotic drugs, which block transmission of the brain chemical dopamine, alleviate motor agitation in people.

The fact that mice missing Arp2/3, and also showing motor abnormalities, seemed to get better with the antipsychotic drug haloperidol suggested that they have too much dopamine in their brains. But the new study found that the overexcitable neurons in the front of their brains connect to and stimulate the neurons dumping the dopamine.

"The most exciting part was when all the pieces of the puzzle fell together," Soderling said. "When Dr. Kim and I finally realized that these three outwardly unrelated phenotypes (spine pruning, hyperactive neurons and excessive dopamine) were actually functionally interrelated with each other, that was really surprising and also very exciting for us," Soderling said.

To confirm the links, the group harnessed cutting edge techniques in genetic engineering and viral gene delivery to switch on neurons in the front of healthy mouse brains. These animals started to move almost instantly, and their brains flooded with dopamine. Haloperidol reversed their symptoms.

Importantly, haloperidol alleviated the abnormal movements, but it did not restore the missing spines in the brains of Arp2/3 mice. As in people with schizophrenia, excessive spine pruning seems to occur earlier in life.

The group plans to study Arp2/3's role in different parts of the brain and the role it has in the mouse's other symptoms, such as sociability defects and cognitive abnormalities. They also plan to examine the potential affect of environmental factors, like stress, on the mouse's brain and symptoms.

"We're very excited about using this type of approach, where we can genetically rescue Arp2/3 function in different brain regions and normalize behaviors," Soderling said. "We'd like to use that as a basis for mapping out the neural circuitry and defects that also drive these other behaviors."

This research was supported by the National Institutes of Health (MH103374, NS059957, NS077986, AA021074, NS039444 and MH082441); the US National Research Foundation; Hungarian Academy of Sciences, by the Hungarian Scientific Research Fund (OTKA, grant K83830); the Szent István University, Faculty of Veterinary Science (Research Faculty Grant 2014); and the North Carolina Biotechnology Center.

CITATION: "Spine pruning drives antipsychotic-sensitive locomotion via circuit control of striatal dopamine," Il Hwan Kim, Mark A. Rossi, Dipendra K. Aryal, Bence Racz, Namsoo Kim, Akiyoshi Uezu, Fan Wang, William C. Wetsel, Richard J. Weinberg, Henry Yin, Scott H. Soderling. Nature Neuroscience, May 4, 2015. DOI: 10.1038/nn.4015

http://www.medscape.com/viewarticle/843623

Chikungunya Update for Clinicians

From a single case introduced in the Caribbean in December 2013, chikungunya has rapidly spread across the Western Hemisphere and remains a risk to US residents traveling to tropical areas.

Joanna Gaines, PhD, MPH, MA, CHES

I'm Dr Joanna Gaines with the Travelers' Health Branch at the Centers for Disease Control and Prevention. I am pleased to be speaking with you today as part of the CDC Expert Video Commentary series on Medscape. Today I will be discussing the current state of chikungunya, the continued risk for importation into the United States, and the ongoing need to counsel travelers to the American tropics on how to avoid such mosquito-borne diseases as chikungunya.

Between December 2013 and March 2015, more than 1.2 million cases of chikungunya have been reported in 44 countries and territories throughout the

Americas. Local transmission has been reported from almost every island in the Caribbean, all countries in Central America, several countries in South America, and parts of Mexico. In 2014, nearly 2500 cases of chikungunya were reported in the United States. Almost all were in returning travelers, with the exception of 11 locally transmitted cases in South Florida. The situation is likely to change. For the most up-to-date information, see CDC's chikungunya website and travel health notices.

There is no way to predict how long the outbreak in the Americas will last. Transmission may continue for years, with increases during the rainy season, from May through December. As with dengue, chikungunya could even become an endemic disease in tropical areas of the Western Hemisphere. Fortunately, because of the temperate climate and use of air conditioning (which keeps mosquitoes out of many homes), in most of the continental United States, sustained transmission is unlikely beyond South Florida and along the US-Mexico border.

US clinicians need to be aware of the ongoing risk for importation among people who have traveled internationally in the previous 2 weeks. Because dengue is also endemic throughout the Americas, both dengue and chikungunya should be included in the differential diagnosis of a traveler with an acute febrile illness and compatible travel history.

Whereas chikungunya is more likely to cause high fever, severe arthralgia, arthritis, rash, and lymphopenia, dengue is more likely to cause neutropenia, thrombocytopenia, hemorrhage, shock, and death. Co-infection with these viruses is possible and has been reported in previous outbreaks.

Because these illnesses are clinically similar, acetaminophen should be used to manage pain in people suspected of having one of these illnesses (aspirin or nonsteroidal anti-inflammatory drugs can increase the risk of bleeding in people with dengue).

Chikungunya and dengue are both nationally notifiable conditions. Healthcare providers should report suspected chikungunya cases to their local or state health department to facilitate diagnosis and mitigate the risk for local transmission.

People with chikungunya develop a high viremia and can infect local mosquitoes if they are bitten.

Travelers going to popular tourist and cruise destinations in the Caribbean and other areas where chikungunya is a risk may not seek a pre-travel consultation or volunteer their travel plans. Clinicians should use primary care visits as an opportunity to ask about upcoming travel, particularly for those patients who are known to be frequent travelers. Anyone planning travel to a tropical destination at any time of year should be counseled on the need to avoid mosquito bites.

General protective measures include:

- ***Using an approved insect repellent when outside;***
- ***Wearing long-sleeved shirts and long pants and socks as much as possible; and***
- ***Staying in accommodations that are air conditioned or well screened.***

The *Aedes* mosquitoes that transmit both chikungunya and dengue are aggressive daytime biters.

Certain travelers are at higher risk for more serious disease, including people with serious underlying medical conditions and people aged 65 or older. Pregnant women infected late in pregnancy are at risk of passing the virus to the newborn baby. People with arthritis appear to be at greater risk of developing persistent joint pain after chikungunya infection.

Until a vaccine or antiviral therapies are available to offer to travelers, the best advice you can provide to your patients to help them avoid mosquito-borne diseases such as chikungunya and dengue is to avoid getting bitten.

Best wishes for safe and healthy travel!

Web Resources

CDC: Chikungunya Virus
Chikungunya Traveler's Information
Differentiating Chikungunya From Dengue: A Clinical Challenge
Protection against Mosquitoes, Ticks, & Other Insects & Arthropods
Chikungunya in South America
Chikungunya in Central America
Chikungunya in the Caribbean
Chikungunya in Mexico

Lieutenant Commander Joanna Gaines, PhD, MPH, MA, CHES, *is a senior epidemiologist with CDC's Travelers' Health Branch. LCDR Gaines received her bachelor's degree from Princeton University. She completed her PhD, MA, and MPH degrees at the University of Alabama at Birmingham, where she studied unintentional injury and violence. LCDR Gaines began her career at CDC in 2010 as an Epidemic Intelligence Service (EIS) Officer assigned to the Waterborne Disease Prevention Branch within the Division of Foodborne, Waterborne, and Environmental Diseases. She has also worked for the Indian Health Service in Anchorage, Alaska. LCDR Gaines enjoys studying a variety of pathogens and populations.*

http://bit.ly/1zB2t94

Space Supervoid Sucks Energy from Light

A vast region of space colder than expected is also largely devoid of galaxies, and the two observations are no coincidence. Clara Moskowitz reports

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The universe is a dark, cold place. But it has a strange region that's even colder than usual. Seen from Earth, it's an area where the ambient cosmic microwave background light—the leftover thermal energy of the big bang—is much chillier than expected. Now astronomers say they've found in the same part of space a so-called supervoid—a large area mostly empty of galaxies. And they think the overlap is no coincidence.

The supervoid extends 1.8 billion light-years across, making it perhaps the largest structure known in the cosmos, according to a report in the Monthly Notices of the Royal Astronomical Society. [István Szapudi et al, Detection of a supervoid aligned with the cold spot of the cosmic microwave background]

The supervoid's relative lack of stuff could have drained energy from light that passed through it, explaining why the microwave background is colder there. Here's how it works:

General relativity tells us that gravity bends spacetime, causing light to travel a curved path near massive objects, as if falling into a bowl. The supervoid, then, with its lack of mass, is akin to a hill. When light travels up that hill, it loses energy.

Normally it would regain the energy upon exiting the void—that is, when it comes down the other side of the hill. But because the expansion of space is accelerating, the hill the light tumbles down is less steep than it was when the light climbed up. And the flatter ride down means less energy recovered than was expended going up. Which translates to a low-energy region—a big chill in the remnant of the Big Bang.

http://nyti.ms/1GZf9q1

Making Sense of the Chemistry That Led to Life on Earth

It was the actions of Jupiter and Saturn that quite inadvertently created life on Earth

By NICHOLAS WADE MAY 4, 2015

It was the actions of Jupiter and Saturn that quite inadvertently created life on Earth — not the gods of the Roman pantheon, but the giant planets, which once orbited much closer to the sun.

Driven outward, they let loose a cascade of asteroids, known as the Late Heavy Bombardment, that blasted the surface of the young Earth and created the deep pockmarks still visible on the face of the moon.

In the heat of these impacts, carbon from the meteorites reacted with nitrogen in Earth's atmosphere to form hydrogen cyanide. Though a deadly poison, cyanide is nonetheless the ancient pathway for inert carbon atoms to enter the chemistry of life.

By the time the Late Heavy Bombardment had eased, some 3.8 billion years ago, the cyanide had rained down into pools, reacted with metals, evaporated, been baked and irradiated with ultraviolet light, and dissolved by streams flowing down to a freshwater pool. The chemicals formed from the interactions of cyanide combined there in various ways to generate the precursors of lipids, nucleotides and amino acids. These are the three significant components of a living cell - lipids make the walls of a cell's various compartments; nucleotides store its information; and amino acids assemble into the proteins that control its metabolism.

All of this is a hypothesis, proposed by John Sutherland, a chemist at the University of Cambridge in England. But he has tested all the required chemical reactions in a laboratory and developed evidence that they are plausible under the conditions expected of primitive Earth.

Having figured out a likely chemistry needed to produce the starting materials of life, Dr. Sutherland then developed this geological scenario because it provides the conditions required by the chemistry.

As for the chemistry itself, that springs from Dr. Sutherland's discovery six years ago of the key to the RNA world.

Biologists have long favored the idea that the first information-carrying molecule of life was not DNA but its close chemical cousin RNA. RNA can store genetic information and act as an enzyme to create more RNA. Like DNA, RNA is made up of a string of chemical units known as nucleotides. Each nucleotide consists of a sugar, ribose in the case of RNA, joined to a base at one end and to a phosphate group at the other.

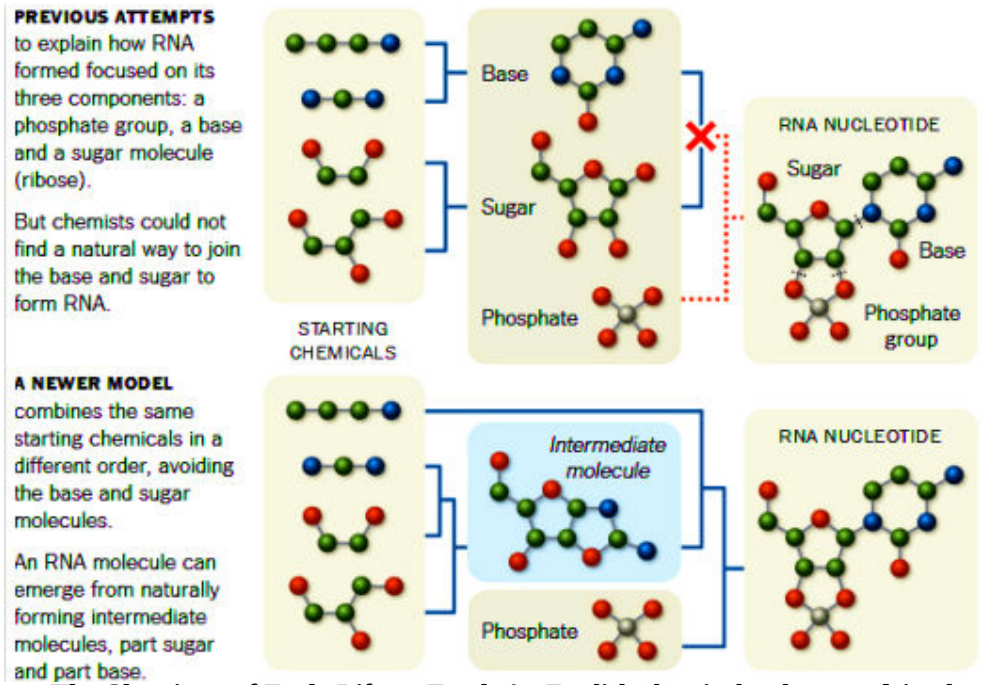
Researchers trying to reconstruct the chemistry that led to life had shown plausible ways in which ribose and the bases could have arisen. But in prebiotic chemistry, the assumed natural chemistry of Earth before life began, they could find no likely way of joining ribose to a base. So daunting was this obstacle that some began to doubt the idea of an RNA world, looking instead for a pre-RNA system.

After 10 years of testing every possible combination of prebiotic chemicals, Dr. Sutherland discovered that the solution was not to build the ribose and the sugar units separately in textbook fashion, but to construct a substance that was part sugar and part base. The addition of another simple chemical converted this hybrid into a ribonucleotide. The door to the RNA world had at last been opened.

If this step was critical, Dr. Sutherland inferred, then the rest of prebiotic chemistry must somehow be related to it. He and colleagues have spent the last six years doing experiments to see how the ribonucleotide chemistry pathway can be linked back to hydrogen cyanide as its starting point, and how other significant prebiotic chemicals might have emerged from the cyanide-to-nucleotide pathway. So far they have demonstrated ways to generate 12 of the 20 amino acids used in proteins, two of the four ribonucleotides of RNA, and glycerol 1-phosphate, the universal building block of the lipids from which cell membranes are formed. Their findings were reported in Nature Chemistry.

Though other researchers have shown how several of these substances could have formed on primitive Earth, these required a variety of conditions, some

incompatible. This is the first time that so many significant life chemicals have been shown to emerge from the same chemistry.



The Chemistry of Early Life on Earth ***An English chemist has been studying how RNA, a building block of living cells, may have emerged from chemicals present on the Earth's surface before the first living cells.*** **Source: Nature By The New York Times**

Dr. Sutherland's report "lays out for the first time a scenario for generating potentially all of the building blocks of life in one geological setting," said Jack W. Szostak, a geneticist at Massachusetts General Hospital who studies the origin of life. "The details of the scenario will be debated for some time, but over all, I think it's a very big advance," he said. Dr. Szostak shared the Nobel Prize in Medicine in 2009 for the discovery of the mechanism that protects the ends of chromosomes.

Dr. Sutherland's chemicals cannot all be mixed together at once. His reaction scheme requires them to be delivered in sequence to a central pool. So in his scenario, separate streams flow over mineral deposits and arrive one by one at the pool. Therein lies a possible weakness, Paul J. Bracher, a chemist at Saint Louis University in Missouri, said in a commentary in Nature Chemistry. "This new report represents a fantastically interesting approach, but origin-of-life chemists still have plenty of work to do in the kitchen," he wrote.

Others have deeper reservations. Steven Benner, the director of the Foundation for Applied Molecular Evolution in Gainesville, Fla., said that many of the reactions in Dr. Sutherland's scheme "aren't real," meaning that pure chemicals might react as proposed in the laboratory but that the process could not be expected to proceed the same way in a natural mix of chemicals.

Dr. Benner also noted that the popular idea of an RNA world is burdened with several unresolved paradoxes. One is that if you have a pool of chemicals and pump energy in, "you don't get life, you get asphalt," he said, meaning that the chemicals will react together to form a gooey tar. Another is that water is essential for life, as are nucleotides, but water destroys nucleotides. A third problem is that RNA is assumed to act as an enzyme and as a store of genetic information, but the two roles require contradictory properties: An enzyme must fold up and be reactive, while a genetic molecule should do neither.

The traditional field of prebiotic chemistry has made some headway, in Dr. Benner's view, but not nearly enough to suggest real answers. "Still, to have these very basic problems left hanging suggests that maybe we're not answering the correct question," he said.

Dr. Sutherland is still trying to find plausible routes to the other two RNA nucleotides. He also hopes to understand how the molecules of life could have been built up from their individual units, a process known as polymerization. "In biology, RNA makes protein and proteins make RNA, so the biology is telling you they work in cahoots with each other," he said. He added that he did not yet know if polymerization would take place on a metal surface, often assumed to be a good catalyst, or inside a cell membrane.

Life may still be unlikely, but at least it's beginning to seem almost possible.

http://bbc.in/1dNlLyh

The man who cut out his own appendix

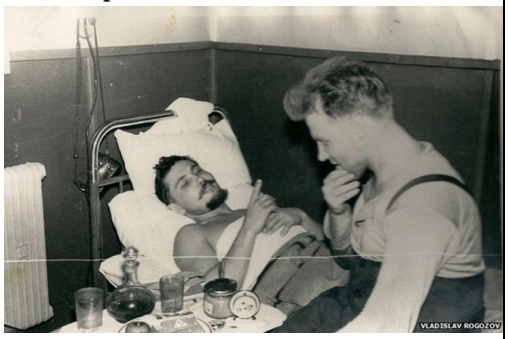
During an expedition to the Antarctic, Russian surgeon Leonid Rogozov became seriously ill.

By Sara Lentati BBC World Service 5 May 2015

He needed an operation - and as the only doctor on the team, he realised he would have to do it himself. As the polar winter rolled in, 27-year-old Leonid Rogozov started to feel tired, weak and nauseous. Later, a strong pain developed down the right side of his abdomen.

"Being a surgeon, he had no difficulty in diagnosing acute appendicitis," says his son, Vladislav. "It was a condition he'd operated on many times, and in the civilised world it's a routine operation. But unfortunately he didn't find himself in the civilised world - instead he was in the middle of a polar wasteland."

Rogozov was part of the sixth Soviet Antarctic expedition - a team of 12 had been sent to build a new base at the Schirmacher Oasis.



The Novolazarevskaya Station was up and running by the middle of February 1961, and with their mission complete the group settled down to see out the hostile winter months.

But by the end of April, Rogozov's life was in danger and he had no hope of outside help. The journey from Russia to the Antarctic had taken 36 days by sea, and the ship wouldn't be back for another year. Flying was impossible because of the snow and blizzards.

Leonid Rogozov lying down talking to his friend Yuri Vereschagin at Novolazarevskaya

"He was confronted with a very difficult situation of life and death," says Vladislav. "He could wait for no help, or make an attempt to operate on himself."

Find out more ***Vladislav Rogozov spoke to Witness on BBC World Service***

Witness Witness podcast BBC World Service

It was not an easy choice. Rogozov knew his appendix could burst and if that happened, it would almost certainly kill him - and while he considered his options, his symptoms got worse. "He had to open his own abdomen to take his intestines out," says Vladislav. "He didn't know if that was humanly possible."

In addition, this was the Cold War, with East and West competing in nuclear, space and polar races - the weight of which rested on both nations and individuals. The commander in charge of the Novolazarevskaya base had to get Moscow's blessing for the operation to go ahead. "If my father was to fail and die it would definitely put a hard hat of negative publicity on the Soviet Antarctic programme," says Vladislav.

Rogozov made his decision - he would perform an auto-appendectomy rather than die not doing anything.

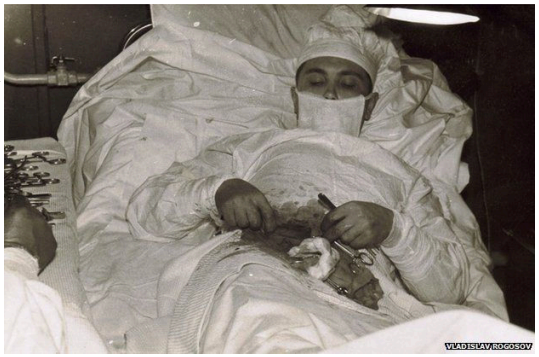
"I did not sleep at all last night. It hurts like the devil! A snow storm whipping through my soul, wailing like 100 jackals," he wrote in his diary. "Still no obvious symptoms that perforation is imminent, but an oppressive feeling of foreboding hangs over me… This is it… I have to think through the only possible way out - to operate on myself… It's almost impossible… but I can't just fold my arms and give up."

Rogozov worked out a detailed plan for how the operation would unfold and assigned his colleagues specific roles and tasks. He nominated two main assistants to hand him instruments, position the lamp, and hold a mirror - he planned to use the reflection to see what he was doing. The station director was also in the room, in case one of the others became faint. "He was so systematic he even instructed them what to do if he was losing consciousness - how to inject him with adrenalin and perform artificial ventilation," says Vladislav. "I don't think his preparation could have been better."

A general anaesthetic was out of the question. He was able to administer a local anaesthetic to his abdominal wall but once he had cut through, removing the appendix would have to be done without further pain relief, in order to keep his head as clear as possible.

"My poor assistants! At the last minute I looked over at them. They stood there in their surgical whites, whiter than white themselves," Rogozov wrote later. "I was scared too. But when I picked up the needle with the novocaine and gave myself the first injection, somehow I automatically switched into operating mode, and from that point on I didn't notice anything else."

Rogozov had intended to use a mirror to help him operate but he found its inverted view too much of a hindrance so he ended up working by touch, without gloves.



As he reached the final and hardest part of the operation, he almost lost consciousness. He began to fear he would fail at the final hurdle.

"The bleeding is quite heavy, but I take my time... Opening the peritoneum, I injured the blind gut and had to sew it up," Rogozov wrote. "I grow weaker and weaker, my head starts to spin. Every four to five minutes I rest for 20 - 25 seconds.

"Finally here it is, the cursed appendage! With horror I notice the dark stain at its base. That means just a day longer and it would have burst… My heart seized up and noticeably slowed, my hands felt like rubber. Well, I thought, it's going to end badly and all that was left was removing the appendix." But he didn't fail. After nearly two hours he had completed the operation, down to the final stitch.

Then, before allowing himself to rest, he instructed his assistants how to wash the surgical instruments and only when the room was clean and tidy did Rogozov take some antibiotics and sleeping tablets. It was a staggering achievement. "Most importantly he was relieved because he had another chance to live," says Vladislav. Rogozov returned to his normal duties just two weeks later.

What if?

"I was a medical student in the early 60s and remember being taught what to do if we found ourselves in the Antarctic with appendicitis. We were told to sit upright with our knees pulled up our chests. Then if the appendix did burst, in this position we had the best chance of pus draining into the bottom of the pelvis and becoming walled off in an abscess, rather than infecting the peritoneum - the membrane that covers the inside of the abdomen. Peritonitis can kill you. We weren't advised to reach for the scalpel."

There was to be one more twist to this extraordinary story. A spell of exceptionally bad weather and thick sea ice meant the ship due to pick them up in April 1962 couldn't get close enough and the team thought they would have to spend another year in Antarctica.

As a surgeon, Rogozov was concerned about losing touch with the medical world, and on a personal level he was trapped in the place where he had the most terrible experience of his life.

In his diary he wrote: "More and more often waves of dull home sickness and hatred of this cursed Antarctica wash over me. How odd it seems that I ever agreed to go on this expedition. All the exoticism of Antarctica was exhausted within a month and in return I'm losing two years of my life. My clinic, which I love more than any worldly pleasure, seems as far from here as Mars."

To the relief of the whole team they were eventually airlifted out, albeit slightly later than planned.

"They had to be evacuated by single-engine planes," says Vladislav. "Very dramatically one of the planes almost dropped into the sea."

Rogozov returned home a national hero. His incredible survival story was a powerful tool for the Soviet propaganda machine. Just 18 days before performing his operation, fellow Russian, Yuri Gagarin, had become the first man in space, and comparisons were drawn between the two men.

"It was a strong parallel because they were both of the same age, 27, they both came from working class backgrounds, and they both achieved something that had not been achieved in human history before. They were prototypes of the ideal national superhero," says Vladislav.

Rogozov was awarded the Order of the Red Banner of Labour which honoured great deeds and services to the Soviet state and society. His bravery was held up as a symbol to the rest of the world: "Look at this generation of young people that our system has produced - young, handsome, smiling, nice fellows," says Vladislav. "But at the same time made of steel and iron determination." Rogozov, though, shunned the publicity. The day after he returned home he went back to his hospital and resumed his career.

Appendectomies are now compulsory for Antarctic explorers from several countries such as Australia. And some in the medical profession have suggested the procedure should be given to any future astronauts leaving the Earth to form a colony on Mars or the Moon.

Looking back at his father's legacy, Vladislav believes it is one of inspiration. "If you find yourself in a seemingly desperate situation when all the odds are against you. Even if you are in the middle of the most hostile environment, do not give up. Believe in yourself and fight, fight for life."

Vladislav Rogozov spoke to Witness *on* BBC World Service.

http://www.eurekalert.org/pub_releases/2015-05/uota-ncg050415.php

New centimeter-accurate GPS system could transform virtual reality and mobile devices

Centimeter-accurate GPS-based positioning system that could revolutionize geolocation

AUSTIN, Texas -- Researchers in the Cockrell School of Engineering at The University of Texas at Austin have developed a centimeter-accurate GPS-based positioning system that could revolutionize geolocation on virtual reality headsets, cellphones and other technologies, making global positioning and orientation far more precise than what is currently available on a mobile device.

The researchers' new system could allow unmanned aerial vehicles to deliver packages to a specific spot on a consumer's back porch, enable collision avoidance technologies on cars and allow virtual reality (VR) headsets to be used outdoors. The researchers' new centimeter-accurate GPS coupled with a smartphone camera could be used to quickly build a globally referenced 3-D map of one's surroundings that would greatly expand the radius of a VR game. Currently, VR does not use GPS, which limits its use to indoors and usually a two- to three-foot radius.

"Imagine games where, rather than sit in front of a monitor and play, you are in your backyard actually running around with other players," said Todd Humphreys, assistant professor in the Department of Aerospace Engineering and Engineering Mechanics and lead researcher. "To be able to do this type of outdoor, multiplayer virtual reality game, you need highly accurate position and orientation that is tied to a global reference frame."

Humphreys and his team in the Radionavigation Lab have built a low-cost system that reduces location errors from the size of a large car to the size of a nickel -- a more than 100 times increase in accuracy. Humphreys collaborated with Professor Robert W. Heath from the Department of Electrical and Computer Engineering and graduate students on the new technology, which they describe in a recent issue of GPS World.

Centimeter-accurate positioning systems are already used in geology, surveying and mapping, but the survey-grade antennas these systems employ are too large and costly for use in mobile devices. The breakthrough by Humphreys and his team is a powerful and sensitive software-defined GPS receiver that can extract centimeter accuracies from the inexpensive antennas found in mobile devices -- such precise measurements were not previously possible. The researchers anticipate that their software's ability to leverage low-cost antennas will reduce the overall cost of centimeter accuracy, making it economically feasible for mobile devices.

Humphreys and his team have spent six years building a specialized receiver, called GRID, to extract so-called carrier phase measurements from low-cost antennas. GRID currently operates outside the phone, but it will eventually run on the phone's internal processor.

To further develop this technology, Humphreys and his students recently co-founded a startup, called Radiosense. Humphreys and his team are working with Samsung to develop a snap-on accessory that will tell smartphones, tablets and virtual reality headsets their precise position and orientation.

The researchers designed their system to deliver precise position and orientation information -- how one's head rotates or tilts -- to less than one degree of measurement accuracy. This level of accuracy could enhance VR environments that are based on real-world settings, as well as improve other applications, including visualization and 3-D mapping.

Additionally, the researchers believe their technology could make a significant difference in people's daily lives, including transportation, where centimeter-accurate GPS could lead to better vehicle-to-vehicle communication technology.

"If your car knows in real time the precise position and velocity of an approaching car that is blocked from view by other traffic, your car can plan ahead to avoid a collision," Humphreys said.

Samsung provided funding to Humphreys' Radionavigation Lab at UT Austin for the centimeter-accurate global positioning system research and plans to continue funding related basic research.

http://www.eurekalert.org/pub_releases/2015-05/tjnj-trr043015.php

Treatment reduces risk of recurrence of C. difficile infection

Treatment with metronidazole or vancomycin and administration of spores of a strain of nontoxigenic C difficile significantly reduced CDI recurrence

Among patients with Clostridium difficile infection (CDI) who recovered following standard treatment with the antibiotics metronidazole or vancomycin, oral administration of spores of a strain of C difficile that does not produce toxins colonized the gastrointestinal tract and significantly reduced CDI recurrence, according to a study in the May 5 issue of JAMA.

C difficile is the cause of one of the most common and deadly health care-associated infections, linked to 29,000 U.S. deaths each year. Rates of CDI remain at unprecedented high levels in U.S. hospitals. Clinical infection also has a recurrence rate of 25 percent to 30 percent among affected patients. Not all strains of C difficile produce toxins. Nontoxigenic C difficile strains that lack the genes for toxin production are also found in the hospital environment and can colonize hospitalized patients, although patients are usually asymptomatic. Gastrointestinal colonization by these nontoxigenic C difficile strains (in both humans and hamsters) has shown promising results as a potential way to prevent CDI, according to background information in the article.

Dale N. Gerding, M.D., of the Edward Hines Jr. VA Hospital, Hines, Il., and Loyola University Chicago, Maywood, Il., and colleagues randomly assigned 173 adult patients who were diagnosed as having CDI (first episode or first recurrence) to receive 1 of 4 treatments: oral liquid formulation of nontoxigenic C difficile strain M3 (VP20621; NTCD-M3), 104 spores/d for 7 days (n = 43), 107 spores/d for 7 days (n = 44), 107 spores/d for 14 days (n = 42), or placebo for 14 days (n = 44). Prior to enrollment, these patients had all successfully completed treatment with metronidazole, oral vancomycin, or both at 44 study centers in the United States, Canada, and Europe.

Among 168 patients who started treatment, 157 completed treatment. Clostridium difficile infection recurrence was 30 percent among patients receiving placebo compared with 11 percent among all patients receiving NTCD-M3. The lowest recurrence was in 5 percent of patients receiving 107 spores/d for 7 days. Fecal colonization with NTCD-M3 occurred in 69 percent of NTCD-M3 patients: 71 percent with 107 spores/d and 63 percent with 104 spores/d. Colonization with NTCD correlated with reduced recurrence of CDI: recurrence occurred in 2 percent patients who were colonized vs 31 percent of patients who received NTCD-M3 but were not colonized.

One or more treatment-emergent adverse events were reported in 78 percent of patients receiving NTCD-M3 and 86 percent of patients receiving placebo. Diarrhea and abdominal pain were reported in 46 percent and 17 percent of patients receiving NTCD-M3 and 60 percent and 33 percent of placebo patients, respectively. Serious treatment-emergent adverse events were reported in 7 percent of patients receiving placebo and 3 percent of all patients who received NTCD-M3. Headache was reported in 10 percent of patients receiving NTCD-M3 and 2 percent of placebo patients.

The researchers write that the mechanism by which NTCD prevents recurrent CDI is not known; however, there may be an association with the presence of NTCD in the stool (colonization) with reduced infection from toxigenic C difficile and in animal models with prevention of CDI when challenged with toxigenic strains.

"The most likely hypothesized mechanism of action of NTCD-M3 is that it occupies the same metabolic or adherence niche in the gastrointestinal tract as does toxigenic C difficile and, once established, is able to outcompete resident or newly ingested toxigenic strains."

The authors note that the sample size of the study was small, so many of the findings should be confirmed in larger studies.

(doi:10.1001/jama.2015.3725; Available pre-embargo to the media at http://media.jamanetwork.com)

Editor's Note: This study was sponsored by ViroPharma Incorporated, which is now part of the Shire group of companies. Please see the article for additional information, including other authors, author contributions and affiliations, financial disclosures, etc.

http://www.eurekalert.org/pub_releases/2015-05/byu-lsi050515.php

Late-night snacking: It it your brain's fault?

New research documents how brains respond to food images at night

After gobbling the fourth Oreo in a row while bathed in refrigerator light, have you ever thought, "That wasn't enough," and then proceeded to search for something more?

Researchers at BYU have shed new light on why you, your friends, neighbors and most everyone you know tend to snack at night: some areas of the brain don't get the same "food high" in the evening.

In a newly published study, exercise sciences professors and a neuroscientist at BYU used MRI to measure how people's brains respond to high- and low-calorie food images at different times of the day. The results showed that images of food, especially high-calorie food, can generate spikes in brain activity, but those neural responses are lower in the evening.

"You might over-consume at night because food is not as rewarding, at least visually at that time of day," said lead author Travis Masterson. "It may not be as satisfying to eat at night so you eat more to try to get satisfied."

The study, which appears in academic journal Brain Imaging and Behavior, also reports that participants were subjectively more preoccupied with food at night even though their hunger and "fullness" levels were similar to other times of the day.

Masterson, who carried out the research for his master's thesis under faculty advisor James LeCheminant, said the intent was to better understand if time of day influences neural responses to pictures of food.

The researchers teamed up with BYU neuroscientist Brock Kirwan to use functional MRI to monitor the brain activity of study subjects while they viewed images of food. The participants viewed 360 images during two separate sessions held one week apart--one during morning hours and one during evening hours.

Subjects looked at images of both low-calorie foods (vegetables, fruits, fish, grains) and high-calorie foods (candy, baked goods, ice cream, fast food). As expected, the researchers found greater neural responses to images of high-calorie foods. However, they were surprised to see lower reward-related brain reactivity to the food images in the evening.

"We thought the responses would be greater at night because we tend to over-consume later in the day," said study coauthor Lance Davidson, a professor of exercise sciences. "But just to know that the brain responds differently at different times of day could have implications for eating."

Nevertheless, researchers noted that the study is preliminary and additional work is needed to verify and better understand the findings. The next research steps would be to determine the extent that these neural responses translate into eating behavior and the implications for weight management.

Masterson, who is heading to Penn State University to work on his PhD in the fall, said the study has helped him pay better attention to how food makes him feel both in the morning and the evening. And as for his late-night eating habits?

"I tell myself, this isn't probably as satisfying as it should be," he said. "It helps me avoid snacking too much at night."

http://www.eurekalert.org/pub_releases/2015-05/m-vlo050515.php

Volcano Loki observed from Earth

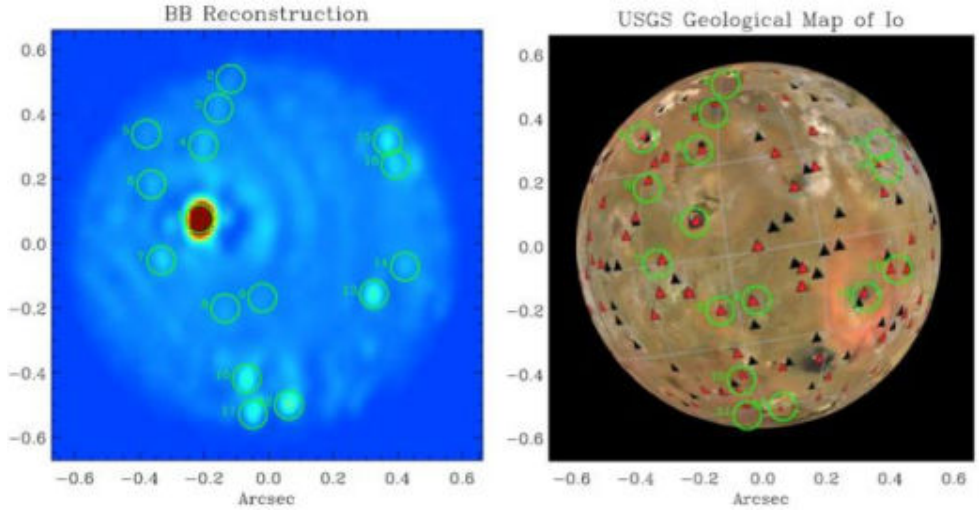
Large Binocular Telescope shows a lava lake on Jupiter's moon Io

With the first detailed observations of a lava lake on a moon of Jupiter, the Large Binocular Telescope Observatory in Arizona places itself as the forerunner of the next generation of Extremely Large Telescopes. The applied high-resolution imaging methods were developed by an international research team including scientists from the Max Planck Institute for Radio Astronomy in Bonn and the Max Planck Institute for Astronomy in Heidelberg.

Io, the innermost of the four moons of Jupiter discovered by Galileo in January 1610, is only slightly bigger than our own Moon but is the most geologically active body in our solar system. Hundreds of volcanic areas dot its surface, which is mostly covered with sulfur and sulfur dioxide.

The largest of these volcanic features, named Loki after the Norse god often associated with fire and chaos, is a volcanic depression called patera in which the denser lava crust solidifying on top of a lava lake episodically sinks in the lake, yielding a raise in the thermal emission which has been regularly observed from

Earth. Loki, only 200km in diameter and at least 600 million km from Earth, was, up to recently, too small to be looked at in details from any ground based optical/infrared telescope.



This is an interferometric image of Jupiter's moon Io taken with the LBT on Dec. 24, 2013 (left) compared to a satellite image on the basis of images from NASA space missions like Voyager 1 and 2 or Galileo (right). The lava lake of the Loki volcano can be seen in dark red on the LBT image. The circles mark the positions of further volcanoes on Io. **LBT Research Team**

With its two 8.4 m mirrors set on the same mount 6 m apart, the Large Binocular Telescope (LBT) has been designed to ultimately provide images with the level of details a 22.8 m telescope would, by combining the light through interferometry. Thanks to the Large Binocular Telescope Interferometer (LBTI), an international team of researchers was able to look at Loki Patera in details for the first time from Earth in a study published today in the Astronomical Journal.

"We combine the light from two very large mirrors coherently so that they become a single, extremely large mirror," says Al Conrad, the lead of the study and a Scientist at the Large Binocular Telescope Observatory (LBTO). "In this way, for the first time we can measure the brightness coming from different regions within the lake."

For Phil Hinz, who leads the LBTI project at the University of Arizona Steward Observatory, this result is the outcome of a nearly fifteen year development. "We built LBTI to form extremely sharp images. It is gratifying to see the system work so well." Phil notes that this is only one of the unique aspects of LBTI. "We built the system both to form sharp images and to detect dust and planets around nearby stars at extremely high dynamic range. The new result from LBTI is a great example of its potential."

LMIRcam, the camera recording the images at the very heart of LBTI in the 3 to 5 micrometers near-infrared band, was the thesis work of Jarron Leisenring as graduate student at the University of Virginia. For Jarron, now an instrument scientist for NIRCam (the Near InfraRed CAMera for the James Webb Space Telescope) at Steward Observatory, "these observations mark a major milestone for me and the instrument team. LMIRcam has already been very productive these past few years; now, interferometric combination provides the last step in harnessing LBTI's full potential and enabling a whole host of new scientific opportunities."

Many raw images delivered by LMIRcam are combined to form a single high-resolution image. "LBTI raw images are crossed by interference fringes. Therefore, these raw images do not look very sharp", explains Gerd Weigelt, a Professor at the Max Planck Institute for Radio Astronomy in Bonn. "However, modern image reconstruction methods, so-called deconvolution, allow us to overcome the interference fringes and achieve a spectacular image resolution."

"While we have seen bright emissions - always one unresolved spot - "pop-up" at different locations in Loki Patera over the years", explains Imke de Pater, a Professor at the University of California in Berkeley, "these exquisite images from the LBTI show for the first time in ground based images that emissions arise simultaneously from different sites in Loki Patera. This strongly suggests that the horseshoe-shaped feature is most likely an active overturning lava lake, as hypothesized in the past."

For Christian Veillet, Director of the Large Binocular Telescope Observatory (LBTO), "this study marks a very important milestone for the Observatory. The unique feature of the binocular design of the telescope, originally proposed more than 25 years ago, is its ability to provide images with the level of detail (resolution) only a single-aperture telescope at least 22.7m in diameter could reach. The spectacular observations of Io published today are a tribute to the many who believed in the LBT concept and worked very hard over more than two decades to reach this milestone."

Veillet adds: "While there is still much work ahead to make the LBT/LBTI combination a fully operational instrument, we can safely state that the Large Binocular Telescope is truly a forerunner of the next generation of Extremely Large Telescopes slated to see first light in a decade (or more) from now."

"Two of the volcanic features are at newly-active locations", explains Katherine de Kleer, a graduate student at the University of California at Berkeley. "They are located in a region called the Colchis Regio, where an enormous eruption took

place just a few months earlier, and may represent the aftermath of that eruption. The high resolution of the LBTI allows us to resolve the residual activity in this region into specific active sites, which could be lava flows or nearby eruptions."

"Studying the very dynamic volcanic activity on Io, which is constantly reshaping the moon's surface, provides clues to the interior structure and plumbing of this moon," remarked team member Chick Woodward of the University of Minnesota. "It helps to pave the way for future NASA missions such as the Io Observer. Io's highly elliptical orbit close to Jupiter is constantly tidally stressing the moon, like the squeezing of a ripe orange, where the juice can escape through cracks in the peel."

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Original paper:

Albert Conrad et al. Spatially resolved M-band emission from Io's Loki patera - Fizeau imaging at the 22.8m LBT Astronomical Journal, 2015 doi: 10.1088/0004-6256/149/5/175

http://www.eurekalert.org/pub_releases/2015-05/uonc-peb050515.php

Popular electric brain stimulation method detrimental to IQ scores

In a double-blinded, randomized study, UNC researchers found that the IQ scores of people who underwent tDCS brain stimulation improved markedly less than did the IQ scores of people in the placebo group

CHAPEL HILL, NC - Using a weak electric current in an attempt to boost brainpower or treat conditions has become popular among scientists and do-it-yourselfers, but a new University of North Carolina School of Medicine study shows that using the most common form of electric brain stimulation had a statistically significant detrimental effect on IQ scores.

Published in the journal Behavioural Brain Research, the study adds to the increasing amount of literature showing that transcranial direct current stimulation - tDCS - has mixed results when it comes to cognitive enhancement.

"It would be wonderful if we could use tDCS to enhance cognition because then we could potentially use it to treat cognitive impairment in psychiatric illnesses," said Flavio Frohlich, PhD, study senior author and assistant professor of psychiatry, cell biology and physiology, biomedical engineering, and neurology. "So, this study is bad news. Yet, the finding makes sense. It means that some of the most sophisticated things the brain can do, in terms of cognition, can't necessarily be altered with just a constant electric current."

Frohlich, though, said that using less common alternating current stimulation - so-called tACS - could be a better approach, one that he has been investigating. Earlier this year, Frohlich's lab found that tACS significantly boosted creativity, likely because he used it to target the brain's natural electrical alpha oscillations, which have been implicated in creative thought.

With tDCS, scientists don't target these brain waves, which represent neuronal patterns of communication throughout regions of the brain. Instead, they use tDCS to target brain structures, such particular regions of the cortex.

The tDCS boom started in 2000, when German scientists published a paper showing that tDCS could change the excitability of neurons in the motor cortex - the brain region that controls voluntary body movement. Since then, there's been an explosion of tDCS studies to try to make neurons more active or less active and therefore change outcomes for a variety of brain functions, such as working memory and cognitive acuity, and for illnesses, such as depression and schizophrenia.

But Frohlich said that some of the studies that have made waves were poorly designed. Some studies were not properly double-blinded or properly placebo controlled. Other studies were very small - less than 10 people.

A recent meta-analysis of a large number of tDCS papers showed that tDCS is far from a magic pill for cognitive enhancement or brain-related health conditions.

"Aside from stimulating the motor cortex, which has very exciting implications for stroke rehabilitation, I think the jury is still out on tDCS," said Frohlich, who is a member of the UNC Neuroscience Center.

In the Behavioural Brain Research study, Frohlich's team - including graduate student Kristin Sellers, the paper's first author - recruited 40 healthy adults, each of whom took the standard WAIS-IV intelligence test, which is the most common and well-validated test of IQ. It includes tests for verbal comprehension, perceptional reasoning, working memory, and processing speed.

A week later, Frohlich's team divided the participants into two groups. Electrodes were placed on each side of each participant's scalp, under which sat the frontal cortex. Duke University collaborator and co-author Angel Peterchev, PhD, created

imaging simulations to ensure Frohlich's team targeted the same parts of the cortex that previous tDCS studies had targeted.

Then the placebo group received sham stimulation - a brief electrical current, which led participants to think they had been receiving the full tDCS. The other participants received the standard tDCS for twenty minutes - a weak electrical current of 2 millioamperes.

All participants then retook the IQ tests. Frohlich expected that most, if not all, IQ scores would improve because of the practice effect, but that tDCS would not markedly improve scores.

Frohlich's team did find that all scores improved. Surprisingly, though, the participants who did not receive tDCS saw their IQ scores increase by ten points, whereas participants who received tDCS saw their IQ scores increase by just shy of six points, on average.

When Frohlich and colleagues analyzed the test scores, they saw that the scores for three of the four main kinds of cognitive tests were very similar between the two groups of participants. But the scores for perceptual reasoning were much lower among people who underwent tDCS.

Perceptual reasoning tests fluid intelligence, which is defined as the ability to think logically and apply innovative problem solving to new problems.

Within the category of perceptual reasoning, the researchers saw the biggest differences in the subcategory of matrix reasoning - when participants viewed two groups of symbols and had to find the one symbol missing from the other group.

Frohlich emphasized, "Our findings do not preclude the possibility that other tDCS paradigms may be less harmful or even beneficial. However, it is time to make sure that everybody uses gold standard, placebo-controlled, double-blind study designs. Also, our study demonstrates the importance of more research on how stimulation interacts with brain activity."

Frohlich stressed that the scientific community should be careful not to create simplistic storylines about tDCS being a 'magic pill' for many brain-related conditions. "There could be dangerous consequences, especially if tDCS is used daily," he said. "Ours was an acute study. We don't know what the long-term effects are. There is so much more we need to understand before tDCS is ready for home use without medical supervision"

Frohlich added, "I think our study demonstrates that we need to think of smarter ways to engage the brain to really target the specific brain dynamics involved in what we want to improve, such as cognition for people with depression or schizophrenia. I think tACS is an option, as well as more sophisticated modalities we've yet to develop."

The National Institutes of Health funded this study.

http://bit.ly/1KqqEy3

This African Plant Leads the Way to Diamond Deposits

A palm-like plant seems to grow only on top of diamond-rich deposits called kimberlite pipes

By Marissa Fessenden

Diamonds are forged about 100 miles below the surface of the Earth where intense heat and pressure turns carbon into shiny gems. Diamonds that have made it to the surface were carried there by intense eruptions rooted deeper than ones the planet sees today. After rocketing upward at 20 to 30 miles per hour, that volcanic material cools into mounds, leaving behind a rocky piles, beneath which stretches a long pipe called a kimberlite. Most diamonds in the world are mined from such kimberlite formations (though some can be formed during meteorite crashes).

Though diamonds aren't as rare as most people believe, the diamond industry is constantly looking for new deposits. Now a geologist may have found an easy way to identify diamond-rich areas: look for a rare plant that seems to grow only those kimberlites, reports Eric Hand for *Science*.

Stephen Haggerty, of Florida International University in Miami and the chief exploration officer of Youssef Diamond Mining Company noticed the plant during surveys in Liberia, where the company owns mining concessions. Hand writes:

It has a stiltlike aerial root system, similar to mangrove trees, and rises to a height of 10 meters or more, spreading spiny, palmlike fronds. He says local people use the fronds for thatching their roofs. Working with botanists from the Royal Botanic Garden, Kew, in the United Kingdom, and the Missouri Botanical Garden in St. Louis, he has tentatively identified the plant as [Pandanus] candelabrum, a poorly understood species in a family that ranges from Cameroon to Senegal. He says it could be a subspecies or a new species altogether. Haggerty has confirmed the presence of the plant at another kimberlite pipe 50 kilometers to the southeast, but it does not seem to grow elsewhere.

Plants signaling that something of interest lays below aren't new in the mining world. People have long known that *Lychinis alpina*, a small plant with pink flowers, heralds copper deposits. More recently a shrub named *Haumaniastrum katagense* has been associated with copper as well. Both plants are unique because they're able to tolerate the high copper content in the soil near deposits. Haggarty suspects that *P. candelabrum* has specifically adapted to grow in

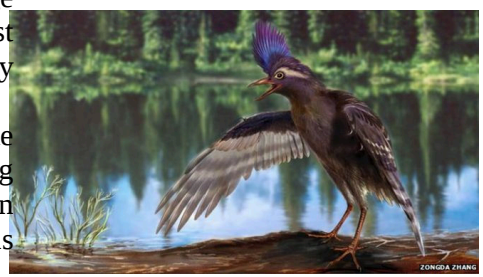
kimberlite soils, which contain a lot of magnesium, potassium and phosphorus.
The researcher wrote up his discovery of the plants' unusual affinity in the journal *Economic Geology*.
The finding could offer a better way to pinpoint new diamond mining sites in the thick jungle. Prospectors are going to "jump on it like crazy," geologist Steven Shirey of the Carnegie Institution for Science in Washington, D.C. told *Science*.
But new diamond deposits are interesting from a scientist's perspective as well. Shirey points out that the diamonds from mines in Liberia could tell researchers about what the Earth's mantle was doing when they were formed, millions of years ago. On the other hand, being an indicator for mining operations can't be good for the plant's longevity.

http://www.bbc.com/news/science-environment-32596726

Feathery fossils peg early birds to even earlier date

Scientists in China have described a new species of early bird, from two fossils with intact plumage dating to 130 million years ago.

Based on the age of the surrounding rocks, this is the earliest known member of the clade that produced today's birds: Ornithuromorpha. It pushes back the branching-out of this evolutionary group by at least five million years. The little bird appears to have been a wader, capable of nimble flight. The discovery is reported in the journal Nature Communications.
Birds began to evolve from the dinosaurs some 150 million years ago at the tail end of the Jurassic period. This is the age of the famous but hotly contested "first bird" Archaeopteryx - now considered by many to be a feathered dinosaur.
Some 20 million years later, when the newfound species was wading and flitting through what would become north-eastern China, palaeontologists believe there was quite a variety of bird life.



The bird, reconstructed here by an illustrator, shows signs of a wading lifestyle

Bare legs

About half of those species were Enantiornithes, a group of early birds with teeth and clawed wings that eventually all died out. The other half, including the new find, were Ornithuromorpha - a group that eventually gave rise to modern birds and looked much more like them. The branching event behind that forked diversity is what the new discovery pushes back in time; previously the earliest known Ornithuromorph was 125 million years old.
The pair of skeletons that define the new species, christened Archaeornithura meemannae, were dug up from the Sichakou basin in Hebei province.
"The new fossil represents the oldest record of Ornithuromorpha," said first author Wang Min, from the Chinese Academy of Sciences in Beijing. "It pushes back the origination date... by at least five million years."

The well-preserved fossils included signs of the animal's plumage

The specimens were well preserved, revealing a number of details about A. meemannae. The bird stood about 15cm tall and its legs, even on the upper regions, had no feathers, which suggests a wading lifestyle.
The size and shape of its bones also suggest good maneuverability in the air.

http://bit.ly/1F5rERB

Spiders sprayed with graphene or carbon nanotubes spin super silk

Spider-Man would be so envious.

21:00 05 May 2015 by Jacob Aron

Spiders have woven webs infused with carbon nanotubes and even graphene, raising the prospect of new materials with record-beating properties.
Graphene – sheets of carbon just one atom thick – is one of the strongest artificial materials, and spider silk is one of the strongest natural ones. So Nicola Pugno of the University of Trento, Italy, wondered what would happen if you combined them.
Pugno and his colleagues captured five spiders from the Pholcidae family and sprayed them with a mixture of water and graphene particles 200 to 300 nanometres wide. They also sprayed another 10 spiders with carbon nanotubes and water to compare the effects of the two materials.
Some spiders produced below-par silk, but others got a major boost. The best fibres came from a spider dosed with nanotubes: it was around 3.5 times as tough and strong as the best unaltered silk, spun by the giant riverine orb spider.

From spiders to silkworms

The only natural material that is stronger than orb spider silk is the material that the teeth of molluscs called limpets are made out of, Pugno and colleagues

revealed earlier this year. The molluscs' teeth stretch more than the spider silk, but are much less tough, meaning they crack more easily.

The team isn't sure how the graphene and carbon nanotubes end up in the silk. One possibility is that the carbon coats the outside of the strands, but Pugno thinks that would not be enough to account for the increase in strength. Instead, he believes the spiders mop up materials in their environment and incorporate them into the silk as they spin. This comes at a cost, however – four of the spiders died soon after being sprayed.

At this early stage it's not clear how such a material will be used, but one possibility is a giant net capable of catching falling aircraft, suggests Pugno. The team also plans to investigate other ways of producing bionic materials, such as dosing silkworms with artificial substances. "This concept could become a way to obtain materials with superior characteristics," he says.

Reference: arxiv.org/abs/1504.06751

http://www.eurekalert.org/pub_releases/2015-05/uoc-nfo050515.php

New form of DNA modification may carry inheritable information

Scientists at the University of Chicago, Harvard, and China have described the surprising discovery and function of a new DNA modification in insects, worms, and algae.

Common DNA modifications occur through methylation, a chemical process that can dramatically change gene expression, which regulates the eventual production of proteins that carry out the functions of an organism. It's all part of a growing new subfield of epigenetics being pioneered by the University of Chicago's Chuan He and his collaborators.

Through epigenetics, organisms sometimes bypass the genetic code to transmit certain traits to their offspring. DNA modifications, without changing DNA sequence, carry out those transmissions.

"The human genome is not static. It contains dynamic DNA modifications that carry key inheritable epigenetic information passed among generations of cells," said He, the John T. Wilson Distinguished Service Professor in Chemistry and a Howard Hughes Medical Institute Investigator.

DNA encodes genetic information in its chemical bases: adenine, cytosine, guanine, and thymine. Previously, scientists had viewed methylated cytosine as the dominant DNA modification found in eukaryotes, a taxonomical classification that includes mammals, insects, worms, plants, and algae.

Three papers in Cell

Now, teams from UChicago, Harvard, and the Chinese Academy of Sciences have identified an adenine DNA methylation that also epigenetically regulates cellular function in green algae, worms, and flies. Their three papers were published online April 30 in the journal Cell. He's research group contributed to all three Cell papers, which report the presence and function of N6-methyladenine (6mA) in the three organisms.

"The conservation of this modification from simple unicellular eukaryotes to vastly different worms and flies indicate its wide presence and functional roles," He said. "All three studies together uncover a potential new epigenetic mark on eukaryotic DNA. They open a new field of biology and chemical biology."

Worms and flies were not previously known to contain DNA methylations. The presence of 6mA in green algae (Chlamydomonas), has been known for more than 30 years, He said, but the phenomenon went largely unexplored. "No one had any idea what it does inside green algae."

In one of the Cell papers, He and 13 co-authors, including Laurens Mets, associate professor in molecular genetics & cell biology at UChicago, unveiled the function of 6mA in Chlamydomonas, a green algae of potential use in biofuel production.

"Genes that have methylated cytosine have been associated with reduced gene expression," said Mets, who counts Chlamydomonas among his research specialties. "What's different about adenine methylation is that it is associated with more strongly expressed genes. It's a missing piece in the puzzle of regulation at the DNA modification level, and that's an exciting thing."

In 2011, He's group opened the new research field of RNA epigenetics. That year his group reported that the FTO protein, which is associated with obesity, can remove 6mA from the messenger RNA of mammalian cells. In subsequent research, He's group discovered and described the writer, eraser, and reader proteins of methylated RNA. Additional studies conducted by researchers globally also have shown the functional significance of RNA methylation in many aspects of biology, including stem cell differentiation and development. The same base modification on DNA is the subject of the current studies reported in the three Cell papers.

DNA modifications in algae

For the Cell study, He's group turned its attention to DNA methylation in green algae. The lead authors of that study were Ye Fu, PhD'12, now a Harvard postdoctoral fellow; and Guan-Zheng Luo, a postdoctoral scholar at UChicago.

"What Ye Fu and Guan-Zheng Luo were able to do is to determine very precisely where the methylated bases are in the genome," Mets explained. "That revealed a whole new set of findings that are also really exciting."

Among these findings, Fu and Luo found a sharply periodic pattern of adenine methylation that corresponds to the main structural feature in the nucleus of eukaryotic cells. This structural feature is a protein complex called a nucleosome. Nucleosomes generally can be found anywhere along the length of DNA except in

highly expressed genes. In the latter situation, nucleosomes display a precisely spaced pattern. Factors that define the precise positioning of nucleosomes have been mysterious for a long time. The new finding provides a new perspective to answer this question.

"We found not only a new DNA modification that affects gene expression, it interestingly marks for active gene expression," He said. This stands in contrast to the previously known DNA modification, the cytosine methylation that tends to mark for repressive gene expression.

Mets said he would like to investigate methylated adenine further to determine its evolutionary origins. "I'm interested in exploring how universal is this mechanism by looking at a wide range of organisms," Mets said. He, meanwhile, plans further studies of 6mA in the DNA in higher eukaryotes such as mammals.

http://bit.ly/1zNrmys

Microbes found at bottom of ocean are our long-lost relatives

SO THAT'S where they've been hiding. An entirely new group of organisms discovered at the bottom of the Arctic Ocean are our closest simple-celled relatives ever found.

- **06 May 2015 by Penny Sarchet**

Approximately 2 billion years ago, complex eukaryotic cells, which make up animals, plants and fungi, split from smaller, simpler cells called prokaryotes. Researchers have now identified our closest relatives from before this split.

Thijs Ettema at Uppsala University, Sweden, and his team discovered the new organisms when they analysed DNA extracted from underwater sediment near Loki's Castle, a region of hydrothermal vents along the Arctic mid-ocean ridge (*Nature*, DOI: 10.1038/nature14447).

Named Lokiarchaea, the organisms are a new type of archaea. Like fellow prokaryotic bacteria, archaea lack a true cell nucleus and other complex cell machinery. But intriguingly, the Lokiarchaea appear to have more than 100 genes coding for sophisticated cellular functions such as deforming cell membranes and forming and transporting bubble-like vesicles around the cell – functions that are usually only seen in eukaryotes like us.

"It is a truly remarkable, landmark discovery," says Eugene Koonin at the National Center for Biotechnology Information in Bethesda, Maryland. It suggests that our sophisticated cells could have evolved from special, more elaborate forms of ancient prokaryote. "We were really blown away when we got the first genome data," says Ettema. "We can now say that the archaeal ancestor of eukaryotes was perhaps already quite complex."

"Ettema's team have certainly thrown the cat among the pigeons," says Anthony Poole at the University of Canterbury in New Zealand. He says that the discovery of Lokiarchaea blurs the lines between archaea and eukaryotes. "It's still 100 per cent archaeon, but the presence of genes we usually associate with eukaryote cell biology is absolutely fascinating." Ettema's team argue that their finding helps bridge the gap between our cells and those of the typical prokaryotic organisms from which we are believed to have evolved.

Others are more sceptical. "We're getting closer to an archaeal ancestor of the eukaryotes," says Nick Lane of University College London. However, even though the Lokiarchaea are relatively complex compared with other known archaea, they lack the large genome and energy-producing mitochondria of true eukaryotic cells. "It's a thousandth of the way towards the complexity of a eukaryote," says Lane. So we can't really call them an intermediate step or a missing link.

Lane believes the crucial step in the evolution of the eukaryotes was acquiring mitochondria, which would have provided the energy to develop more complicated cellular processes and acquire a larger genome. Ettema does not think the Lokiarchaea have mitochondria, but he says some form of intracellular transport may have evolved before our ancestors acquired their powerhouses.

And while DNA data shows that the Lokiarchaea are our closest known prokaryotic relatives, they may still be very different from the common ancestor that we shared 2 billion years ago.

Unfortunately, we cannot know exactly how the Lokiarchaea use their genes until we can observe one of their cells directly. Ettema's team did not actually see the cells: they used computational methods to piece together the genomes from the DNA found in the seafloor sediment.

Archaea can be particularly difficult to collect and culture in a laboratory, so we may never get a good look at our long-lost prokaryotic cousins.

http://www.eurekalert.org/pub_releases/2015-05/si-nsc050515.php

New stem cell may overcome hurdles for regenerative medicine

Scientists at the Salk Institute have discovered a novel type of pluripotent stem cell--cells capable of developing into any type of tissue--whose identity is tied to their location in a developing embryo.

LA JOLLA-- This contrasts with stem cells traditionally used in scientific study, which are characterized by their time-related stage of development.

In the paper, published May 6, 2015 in Nature, the scientists report using these new stem cells to develop the first reliable method for integrating human stem cells into nonviable mouse embryos in a laboratory dish in such a way that the human cells began to differentiate into early-stage tissues.

"The region-specific cells we found could provide tremendous advantages in the laboratory to study development, evolution and disease, and may offer avenues

for generating novel therapies," says Salk Professor Juan Carlos Izpisua Belmonte, senior author of the paper and holder of Salk's Roger Guillemin Chair.

The researchers dubbed this new class of cells "region-selective pluripotent stem cells," or rsPSCs for short. The rsPSCs were easier to grow in the laboratory than conventional human pluripotent stem cells and offered advantages for large-scale production and gene editing (altering a cell's DNA), both desirable features for cell replacement therapies.

To produce the cells, the Salk scientists developed a combination of chemical signals that directed human stem cells in a laboratory dish to become spatially oriented.

They then inserted the spatially oriented human stem cells (human rsPSCs) into specific regions of partially dissected mouse embryos and cultured them in a dish for 36 hours. Separately, they also inserted human stem cells cultured using conventional methods, so that they could compare existing techniques to their new technique.

While the human stem cells derived through conventional methods failed to integrate into the modified embryos, the human rsPSCs began to develop into early stage tissues. The cells in this region of an early embryo undergo dynamic changes to give rise to all cells, tissues and organs of the body. Indeed the human rsPSCs began the process of differentiating into the three major cell layers in early development, known as ectoderm, mesoderm and endoderm. The Salk researchers stopped the cells from differentiating further, but each germ layer was theoretically capable of giving rise to specific tissues and organs.

Collaborating with the labs of Salk Professors Joseph Ecker and Alan Saghatelian, the Izpisua Belmonte team performed extensive characterization of the new cells and found rsPSCs showed distinct molecular and metabolic characteristics as well as novel epigenetic signatures--that is, patterns of chemical modifications to DNA that control which genes are turned on or off without changing the DNA sequence.

"The region selective-state of these stem cells is entirely novel for laboratory-cultured stem cells and offers important insight into how human stem cells might be differentiated into derivatives that give rise to a wide range of tissues and organs," says Jun Wu, a postdoctoral researcher in Izpisua Belmonte's lab and first author of the new paper. "Not only do we need to consider the timing, but also the spatial characteristics of the stem cells. Understanding both aspects of a stem cell's identity could be crucial to generate functional and mature cell types for regenerative medicine."

Other authors on the paper include: Daiji Okamura, Mo Li, Keiichiro Suzuki, Li Ma, Zhongwei Li, Chris Benner, Isao Tamura, Marie N. Krause, Joseph R. Nery, Zhuzhu Zhang, Tomoaki Hishida, Yuta Takahashi, Emi Aizawa, Na Young Kim, Concepcion Rodriguez Esteban, Alan Saghatelian, Joseph Ecker, Chongyuan Luo, Yupeng He, all of the Salk Institute; Tingting Du, and Bing Ren of the University of California, San Diego; Jeronimo Lajara and Pedro Guillen, of UCAM Universidad Católica San Antonio, Murcia, Spain; Josep M. Campistol, Hospital Clinic of Barcelona, Spain; and Pablo Ross of the University of California, Davis.

The research was supported by the Universidad Católica San Antonio, the Howard Hughes Medical Institute, the Fundacion Pedro Guillen, the G. Harold and Leila Y. Mathers Charitable Foundation, the Leona M. and Harry B. Helmsley Charitable Trust and the Moxie Foundation.

http://www.eurekalert.org/pub_releases/2015-05/sumc-ubi050615.php

Ulcer-causing bacteria induces stomach stem cell growth in mice, Stanford researchers find

The ulcer-causing bacterium Helicobacter pylori can directly interact with stomach stem cells, causing the cells to divide more rapidly, according to a new study by researchers at the Stanford University School of Medicine.

The increased cell division was observed in mice, but the findings could explain why *H. pylori* is a risk factor for gastric cancer in humans, the researchers said. They used 3-D microscopy to identified colonies of the bacteria deep within human stomach glands, where stem cells and precursor cells that replenish the stomach's lining reside.

One of every two people has *H. pylori* in their stomachs. It's one of the few organisms capable of surviving the harsh acidic environment. While the majority of people remain asymptomatic, in about 15 percent of those infected the bacteria causes painful ulcers, and in another 1 percent the bacteria contribute to stomach cancer, the third-most lethal cancer worldwide.

Although the infection can be successfully treated with antibiotics, those who develop cancer are often unaware of their condition until the tumor is large enough to interfere with stomach functions. "The bacteria will be brewing for many years, and when the cancer starts to cause symptoms it may be too late," said Manuel Amieva, MD, PhD, associate professor of pediatrics and of microbiology and immunology.

Amieva is the senior author of the paper describing the findings. The paper was published online May 1 in *Gastroenterology*. The lead author is Michael Sigal, MD, PhD, a former postdoctoral scholar.

Identifying *H. pylori*'s hideout

H. pylori has long been known to evade stomach acid by taking shelter in the protective mucus that covers the organ's epithelial cell lining. The bacteria grow directly on the surface of the epithelial cells, injecting a signaling protein, called CagA, to trick the cells into delivering nutrients to where the bacteria are. The signaling protein also stimulates stem cells to divide faster, the researchers found.

Epithelial cells are short-lived and constantly replaced by new ones that originate from stem cells residing in tiny glands throughout the stomach: The stem cells divide into precursor cells, which populate the middle of the glands. Then precursor cells give rise to the mature epithelial cells.

The passage into and out of the gland is narrow: Its diameter is only about four times wider than a single *H. pylori* cell, and filled with mucus. Earlier research in mice by Sigal and Amieva showed that some *H. pylori* swam into the glands, but it wasn't known if the bacteria actively grew there, or if this behavior occurred in humans. A more systematic study was necessary, but the difficulty lay in finding appropriate human stomach samples to image. While stomach biopsies are plentiful, they provide shallow samples from the top layer of the stomach and omit the deeper tissues the researchers needed.

"You don't want to go all the way through -- it would be like giving the patient a big ulcer," Amieva said.

The researchers came up with the idea of sampling stomach tissues removed during weight-loss surgery. These samples came from healthy stomachs, in which *H. pylori* was not actively causing ulcers or cancer. After identifying tissue infected with particular strains of *H. pylori*, they used confocal microscopy to reconstruct 3-D images of the glands from four stomachs with *H. pylori*. All four showed colonies of the spiral-shaped bacteria clustered about two-thirds of the way into the gland, where fast-dividing precursor cells reside.

Unexpectedly, the researchers found a smaller number of bacterial colonies at the base of the glands, where the stem cells reside. When they went back to their mouse models, they discovered about 30 percent of the glands colonized by *H. pylori* had bacteria at the base of the glands.

H. pylori affects stem cells

This unanticipated finding shed light on how *H. pylori* could influence cells to turn cancerous. Cancer is thought to develop slowly as the cell acquires mutations in the DNA that override cellular controls and increase cell proliferation. Even though *H. pylori* had been shown to manipulate cellular controls, the mature stomach's epithelial cells don't live long enough to acquire mutations.

"Once they reach the surface of the stomach, the cells live for about 24 hours," Amieva said. "It's hard to imagine *H. pylori* doing something to those cells that would lead to cancer."

But the stem cells are extremely long-lived, and *H. pylori* infections often start in childhood. So there would be plenty of time for the bacteria to interact and change the stem cells.

To observe how *H. pylori* might modify stem cell behavior, the researchers turned to a mouse strain used in developmental biology. The stem cells of the mouse express fluorescent markers, which allowed the scientists to identify the stem cells and track their daughter cells.

Two weeks after infection with *H. pylori*, the mice's glands were noticeably longer and more inflamed than those of uninfected mice. The stem cells in the glands of infected mice were also dividing more actively. The researchers suspected CagA might be involved. To confirm this hypothesis, they infected mice with *H. pylori* that can't inject CagA, and while the bacteria still colonized the glands, they observed less inflammation and stem cell growth.

Richard Peek, MD, a professor of medicine and cancer biology at Vanderbilt University who was not involved in the study, said the paper was "beautiful, almost artistic" and that by "using cutting-edge technology to identify a subpopulation niche in the stomach, the research has opened up a new field of investigation."

Other Stanford co-authors are former graduate student Josephine Lee, PhD; postdoctoral scholars Ryan Honaker, PhD, and Catriona Logan, PhD; life science technician Rachel Cooper; Ben Passarelli, director of computing; Roeland Nusse, PhD, professor of developmental biology; Michael Rothenberg, MD, PhD, instructor of medicine; and Donna Bouley, DVM, PhD, professor of comparative medicine.

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http://www.bbc.com/news/technology-32607688

IBM's Watson supercomputer to speed up cancer care

Watson can sift through medical data in minutes, compared to the weeks it would take a human

IBM's supercomputer Watson will be used to make decisions about cancer care in 14 hospitals in the US and Canada, it has been announced. Using computers to trawl through vast amounts of medical data speeds up the diagnosis process. The system will help assess individual tumours and suggest which drug should be used to target them. Doctors have welcomed the new computer which will learn from each case it examines.

"When you are dealing with cancer, it is always a race," said Dr Lukas Wartman, assistant director of cancer genomics at the McDonnell Genome Institute at Washington University in St. Louis, one of those signed up to use the Watson system.

"As a cancer patient myself, I know how important genomic information can be. "Unfortunately, translating cancer-sequencing results into potential treatment options often takes weeks with a team of experts to study just one patient's tumour and provide results to guide treatment decisions. Watson appears to help dramatically reduce that timeline," he explained.

Pressing issue

There could be alternatives to the standard treatments for cancer

Most people currently diagnosed with cancer will receive surgery, chemotherapy or radiation treatment.

But as genetic sequencing becomes increasingly accessible and affordable, some patients are starting to benefit from treatments that target their specific cancer-causing genetic mutations.

However the process is very time-consuming - a single patient's genome represents more than 100 gigabytes of data - and this needs to be combined with other medical records, journal studies and information about clinical trials.

What would take a clinician weeks to analyse can be completed by Watson in only a few minutes.

"The technology that we're applying to this challenge brings the power of cognitive computing to bear on one of the most urgent and pressing issues of our time - the fight against cancer - in a way that has never before been possible," explained Steve Harvey, vice president of IBM Watson Health.

According to Mr Harvey, Watson "will look for actionable targets", although he acknowledged that, "when institutions do genetic sequencing, only about half the cases come back with something actionable".

Sometimes it is impossible to identify the main mutation and, in other cases, no targeted therapy currently exists.

Those collaborating with IBM include the Cleveland Clinic, the Fred & Pamela Buffett Cancer Centre in Omaha and the Yale Cancer Centre.

Eleven others will join the programme by the end of 2015 and each will pay an undisclosed subscription fee to IBM.

Corporate medicine

The link-up is part of an increasingly close relationship between the medical community and technology corporations.

Apple revealed this week that it plans to develop apps for the iPhone that will allow users to take DNA tests which may reveal which diseases and health conditions they are likely to develop

It also recently teamed up with IBM to allow the software that helps gather health data from iPhones to be used by Watson.

IBM is convinced that Watson can "help change the face of healthcare" but it has even bigger ambitions for its cognitive computing platform.

Speaking at an IBM event this week, the firm's chief executive Ginni Rometty made a bold prediction for the technology, saying: "in the future, every decision mankind makes, every decision, is going to be informed by a cognitive system like Watson and, as a result, our lives in this world are going to be better for it."

http://www.medscape.com/viewarticle/844153

Topol: Time to End Routine Mammography

Mammography Is a Recipe for Net Harm

Eric J. Topol, MD

The medical community prides itself on evidence to drive important decision-making. But when the evidence is contrary to entrenched medical practice, it has a hard time coming to terms. Such is the case for mammography recommendations. All of the data now available point to significant net harm—far more risk than benefit— for routine mammography. If this were a drug, the US Food and Drug Administration (FDA) would never approve it. Last year, the Swiss Medical Board, after reviewing all of the data, recommended abolishing mammography.[1] But last week, the US Preventive Services Task Force (USPSTF) issued new draft recommendations regarding who should undergo screening and how often. There was no support for routine screening in women younger than 50 or older than 74 years. But the recommendation for women aged 50-74 years is to undergo mammography every 2 years. There has never been a large study of mammography done every 2 years, so the basis for that periodicity of screening is questionable. But there are abundant data for annual screening and they are not at all supportive of continuing this practice.

A systematic assessment based on all of the evidence available from 1960-2014 showed that for 10,000 women in their 50s, who are screened annually over the course of a decade, there are only 5 individuals whose breast cancer deaths are prevented.[2] But there are over 6100 women who have false-positive tests that lead to additional imaging and unnecessary biopsy procedures. This > 60% false-positive rate is an indicator of a remarkably poor test with respect to accuracy, no less the large toll of emotional turmoil that it engenders.

What about all of the biopsies that are performed? A recent study also underscored yet another level of imprecision: the problem of interpreting biopsies by pathologists when there is agreement among three experts about the presence of cancer only 75% of the time.[3] Added to the net harm of mammography is overdiagnosis, which occurs in 20%-30% of women who have an abnormal result but in whom cancer would not be apparent unless the scan was performed. Nevertheless, these women often undergo surgery and receive chemotherapy or radiation (or a combination of all of these treatments), even though there is little to no impact on prognosis. Such individuals typically believe that their lives have been saved even though the data point against that assertion. A Harvard study published in the current issue of *Health Affairs* demonstrated that the cost of these false-positive studies and overdiagnosis was approximately $4 billion per year.[4]

This is on top of the current US costs of annual mammography of nearly $10 billion.

It is time to reboot how we screen for breast cancer. Until now, the use of mass screening suggests that we are unable to differentiate the risk in any given individual. So instead of a smart approach that uses family history and genetics, we have dumbed it down and treated all women the same. As a result, we have come to rely on a test that is notoriously inaccurate but has become a fixed part of American medical practice since it was introduced almost 50 years ago. With the tens of millions of low-risk women unnecessarily undergoing screening each year, any test would be vulnerable to a high rate of false positives. That applies to higher-resolution scans, too, such as magnetic resonance, digital mammography and ultrasound. Indeed, there is a better path forward.

Why Family History and Genomics Matter

There is strong evidence that family history is critical for defining risk. Beyond family history, we have the ability to sequence the genes known to carry high-risk mutations. Dr Mary-Claire King, who discovered the *BRCA1* gene, has advocated that all women age 30 and older should be screened for mutations that carry a high risk for breast and ovarian cancer.[5] She's right. And at some point, why not add men, who unknowingly can pass along important *BRCA* mutations to their daughters?

We didn't have a way to widely implement such a recommendation until this past week when a collaboration, called BRCA Share, was reported between the two largest central lab companies—Laboratory Corporation of America and Quest Diagnostics —as was the announcement of a new genetic testing company called Color Genomics. For $249, Color Genomics is offering, via a saliva sample, sequencing of the *BRCA* genes along with 17 other genes that carry a high risk for familial cancer. For 1 year of mammography costs in the United States, we could now perform such genetic testing for over 56 million women. The unrelenting plummeting of the cost of sequencing—and a much more expansive approach to the whole genome (instead of just ~20 genes)—is just around the corner.

When she announced her choice to undergo bilateral mastectomy in 2013, Angelina Jolie wrote in an op-ed in *The New York Times* : "But today it is possible to find out through a blood test whether you are highly susceptible to breast and ovarian cancer, and then take action. Life comes with many challenges. The ones that should not scare us are the ones we can take on and take control of." Just a couple of years later, the Angelina Effect on heightening awareness and the US Supreme Court decision against Myriad Genetics' *BRCA* testing monopoly have introduced exciting opportunities for adopting a new approach. We shouldn't be scared of it. It doesn't even require a blood test anymore. We should take it on, study it, and exploit the progress in genomic science to develop an intelligent, evidence-based, and economically attractive precise path forward.

References

1 Biller-Andorno N, Jüni P. Abolishing mammography screening programs? A view from the Swiss medical board. N Engl J Med. 2014; 370:1965-196. Abstract

2 Elmore JG, Kramer BS. Breast cancer screening toward informed decisions. JAMA. 2014;311:1298-1299. Abstract

3 Elmore JG, Longton GM, Carney PA, et al. Diagnostic concordance among pathologists interpreting breast biopsy specimens. JAMA. 2015;313:1122-1132. Abstract

4 Ong MS, Mandl KD. National expenditure for false-positive mammograms and breast cancer overdiagnoses estimated at $4 billion a year. Health Aff (Millwood). 2015:34;576-583. Abstract

5 King, MC, Levy-Lahad E, Lahad A. Population-based screening for BRCA1 and BRCA2. 2014 Lasker Award. JAMA. 2014;312:1091-1092. Abstract

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US army calls for ideas on invisible uniforms for soldiers

The US army has said it wants invisibility cloaks for its soldiers within 18 months. How realistic is that?

06 May 2015 by David Hambling

The US army wants invisibility cloaks for its soldiers. Not just that – it has announced that it wants to test the best contenders within the next 18 months. Seems a bit unrealistic? Well, we may not be as far away as you think.

In 2006, John Pendry, a theoretical physicist at Imperial College London, showed that it should be possible to bend light around an object and hide it using metamaterials – structures engineered at microscopic levels to channel electromagnetic waves. Since then, many devices trumpeted as invisibility cloaks have been described, but they only work in the lab with specific wavelengths or from certain angles.

Now the US army has made a call for proposals from companies for wearable camouflage with a chameleon-like ability to change according to the background. So how will they manage this? Metamaterials are probably the best solution: previous efforts in this field using technology like LEDs were hampered by power and computing requirements.

But although they can bend light, metamaterials cannot make things disappear completely.

"Complete invisibility of macroscopic objects for all visible colours is fundamentally impossible," says Martin Wegener of the Karlsruhe Institute of Technology in Germany. His team has created cloaks from photonic crystals that work for certain wavelengths, but bending light over the entire spectrum is forbidden by relativity.

"This means that you may see less of something at a particular colour, but see it at all other colours," says Wegener.

The wearer would be effectively transparent at some wavelengths but not all, rendering them as a coloured shadow or ghost image.

Contractors will demonstrate the feasibility of their approach in the first six months of the programme. Those selected for the following one-year phase will submit 10 prototype uniforms for testing. These need to work in all terrain from all angles. They also need to function across a wide range of temperatures, in rain and snow, and without hampering a soldier's normal duties.

If the adaptive camouflage requires a power source, this must weigh no more than 0.45 kilograms and provide at least 8 hours of operation.

Some firms claim to be on their way there already. Guy Cramer, CEO of Canadian camouflage makers Hyperstealth Biotechnology, says he demonstrated metamaterial camouflage to US military scientists last year, and that the new project will allow him to move forward with it. But Cramer won't yet reveal details or release photographs of the material.

Metamaterials might be used to generate adaptive camouflage patterns rather than for cloaking, suggests Andrea di Falco of the University of St Andrews, UK.

The new specimens will be compared with existing camouflage patterns using standard NATO tests, indicating that something less than complete invisibility is expected.

However, as Wegener points out, the word "invisible" can mean different things. If the wearer looks like a shadow among other shadows and cannot be identified as a person, they may be invisible enough for military purposes.

http://www.eurekalert.org/pub_releases/2015-05/uog-aeo050715.php

Antioxidant effects of coffee by-products 500 times greater than vitamin C

Coffee silverskin (the epidermis of the coffee bean) is usually removed during processing, after the beans have been dried, while the coffee grounds are normally directly discarded.

It has traditionally been assumed that these by-products - coffee grounds and coffee silverskin, have few practical uses and applications. Spent coffee grounds are sometimes employed as homemade skin exfoliants or as abrasive cleaning products. They are also known to make great composting agents for fertilizing certain plants. But apart from these limited applications, coffee by-products are by and large deemed to be virtually useless. As such, practically all of this highly contaminating 'coffee waste' ends up in landfills across the globe and has a considerable knock-on effect on the environment.

However, a UGR research team led by José Ángel Rufián Henares set out to determine the extent to which these by-products could be recycled for nutritional purposes, thereby reducing the amount of waste being generated, as well as benefitting coffee producers, recycling companies, the health sector, and consumers.

In an article published in the academic journal Food Science and Technology, the researchers demonstrate the powerful antioxidant and antimicrobial properties of the coffee grounds and silverskin, which are highly rich in fibre and phenols. Indeed, their findings indicate that the antioxidant effects of these coffee grounds are 500 times greater than those found in vitamin C and could be employed to create functional foods with significant health benefits.

Moreover, Professor Rufián Henares points out: "They also contain high levels of melanoidins, which are produced during the roasting process and give coffee its brown colour. The biological properties of these melanoidins could be harnessed for a range of practical applications, such as preventing harmful pathogens from growing in food products." However, he also adds: "If we are to harness the beneficial prebiotic effects of the coffee by-products, first of all we need to remove the melanoidins, since they interfere with such beneficial prebiotic properties."

The researchers conclude that processed coffee by-products could potentially be recycled as sources of new food ingredients. This would also greatly diminish the environmental impact of discarded coffee by-products.

The Ministry of Economics and Finance has recently allocated a new research project to the team under the 'State R&D programme', in order to enable them to conduct further studies in the area and re-assess the potential value of coffee by-products.

http://www.eurekalert.org/pub_releases/2015-05/uoc--als050515.php

As life slips by: Why eye movement doesn't blur the picture

Two specific proteins bind during development to stabilize the brain cells that allow us to see things clearly, even as we move

Researchers at University of California, San Diego School of Medicine and Shiley Eye Institute have identified the molecular "glue" that builds the brain connections that keep visual images clear and still, even as objects or your eyes move. Using mouse models, the researchers demonstrate that image stabilization depends upon two proteins, Contactin-4 and amyloid precursor protein, binding during embryonic development. The study is published May 7 by Neuron.

"In the visual system, precise connections between your eyes and brain help you see specific things and make sure those images are clear and crisp," said senior author Andrew D. Huberman, PhD, assistant professor of neurosciences, neurobiology and ophthalmology. "Sensors in the eye also detect movement and

connect to the brain in just the right way to tell your eyes to move in the right direction without blurring images, the way a camera does if you try to take a picture while moving. Until now, we didn't really understand how the eye and brain control that on a molecular level."

To determine exactly how your eyes and brain work together to keep things steady, Huberman, lead author Jessica Osterhout and team labeled specific sets of neurons in the brain that make specific connections -- a technique pioneered by Huberman's lab. This approach allows researchers to look at individual components of the visual network and eventually identify the exact genes those cells switch on during development, as they make the appropriate connections.

From this, the team found Contactin-4, an adhesion molecule. They determined that Conactin-4's expression is very specific to those cells in the eye involved in image stabilization. When the researchers mutated Contactin-4, the circuit didn't form properly and visual cells didn't talk to the brain correctly. On the other hand, when they added Contactin-4 to a cell that doesn't normally produce it, that one additional protein was all the cell needed make the circuits for a steady eye-brain connection.

Then the team went looking for proteins that bind Contactin-4. They uncovered amyloid precursor protein, which has been widely studied for its role in Alzheimer's disease, but is also known to be an important factor in normal brain development. If amyloid precursor protein isn't available, the researchers discovered, Contactin-4 can't control development of the visual circuitry.

Based upon these findings, Huberman and colleagues hypothesize that there are also very specific sets of genes that make sure the correct neurons make the correct connections in other aspects of neural circuitry, in addition to vision. And these genes are very likely important for accurate sensory perception and behavior.

Next, Huberman and his team plan to take a closer look at how these genes and precise neural connections go wrong in cognitive diseases. For example, since the Contactin-4 gene is located in a cluster of genes that have been implicated in some forms of autism, they want to know if aberrations in that particular gene might play a role in development of the disease.

"My lab is also interested in figuring out how to reconnect or regenerate circuits damaged by injury or disease," Huberman said.

Co-authors of this study include Benjamin K. Stafford, and Phong L. Nguyen, UC San Diego; Yoshihiro Yoshihara, RIKEN Brain Science Institute.

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http://www.eurekalert.org/pub_releases/2015-05/uobc-mrm050415.php

MESSENGER reveals Mercury's magnetic field secrets

New data from MESSENGER reveals Mercury's magnetic field is almost four billion years old

New data from MESSENGER, the spacecraft that orbited Mercury for four years before crashing into the planet a week ago, reveals Mercury's magnetic field is almost four billion years old. The discovery helps scientists piece together the history of Mercury, the closest planet to the sun and one about which we knew very little before MESSENGER.

NASA's MESSENGER probe left Earth in 2004, reached Mercury in 2008 and has orbited the planet since 2011, sending valuable data back to scientists. A study detailing the planet's ancient magnetic field was published today in Science Express. Researchers used data obtained by MESSENGER in the fall of 2014 and 2015 when the probe flew incredibly close to the planet's surface - at altitudes as low as 15 kilometers. In the years prior, MESSENGER's lowest altitudes were between 200 and 400 kilometers.

"The mission was originally planned to last one year; no one expected it to go for four," said Catherine Johnson, a University of British Columbia planetary scientist and lead author of the study. "The science from these recent observations is really interesting and what we've learned about the magnetic field is just the first part of it."

Scientists have known for some time that Mercury has a magnetic field similar to Earth's, but much weaker. The motion of liquid iron deep inside the planet's core generates the field.

Mercury is the only other planet besides Earth in the inner solar system with such a magnetic field. There is evidence that Mars once had a magnetic field but it disappeared at some point over 3 billion years ago.

When MESSENGER flew close to the planet, its magnetometer collected data on the magnetism of rocks in Mercury's surface. Those tiny signals revealed that Mercury's magnetic field is very ancient, between 3.7 and 3.9 billion years old. The planet itself formed around the same time as Earth, just over 4.5 billion years ago.

"If we didn't have these recent observations, we would never have known how Mercury's magnetic field evolved over time," said Johnson, also a scientist at the Planetary Science Institute. "It's just been waiting to tell us its story."

Background

Orbiting Mercury in a spacecraft:

One of the biggest challenges of the MESSENGER mission was getting the spacecraft into orbit around Mercury. Because the planet is so close to the sun,

there was a risk that the spacecraft would get pulled into the sun, rather than go into orbit around Mercury. Engineers also had to deal with the issue of high temperatures. MESSENGER was designed with a protective sunshield to keep the side of the spacecraft facing the sun cool. The engineers also designed large elliptical orbits around Mercury that allowed the spacecraft to spend time far from the planet in each orbit and cool off. Between 2011 and 2015, MESSENGER completed over 4,000 orbits of the planet. *More images here: http://www.nasa.gov/mission_pages/messenger/multimedia/messenger_gallery.html*

http://www.eurekalert.org/pub_releases/2015-05/bu-bri050715.php

Brandeis researchers identify potential cause of schizophrenic symptoms

Abnormal brain waves may provide drug target for therapeutic treatments

Schizophrenia affects millions of people worldwide but the cause of its wide-ranging symptoms remains largely unknown.

At Brandeis University, researchers believe they have discovered an abnormality in the schizophrenic brain that could be responsible for many of the disease's symptoms and could provide a drug target for therapeutic treatments.

Led by John Lisman, the Zalman Abraham Kekst Chair in Neuroscience and professor of biology, the research team published their findings in a recent issue of the Journal of Biological Psychiatry. The paper was co-authored by Aranda Duan, Carmen Varela, Yuchun Zhang, Yinghua Shen, Lealia Xiong, and Matthew Wilson.

Unusual neural oscillations -- brain waves -- have long been associated with schizophrenia. The oscillations, called delta waves, are similar to slow oscillations seen in normal brains during sleep, but in schizophrenic brains, they occur during wakefulness. The connection between these oscillations and schizophrenic symptoms, particularly cognitive deficits such as memory impairment, has long been unclear.

Lisman and his team set out to understand that connection by artificially producing delta waves in mammalian brains using a new technique called optogenetics, which activates brain signals using light.

When the delta frequency light was turned on, Lisman observed disruption in the working memory of rats. When it was turned off, the rodents were once again able to perform working memory tasks. More important, Lisman and his team were able activate the abnormal oscillations only in a tiny subpart of the thalamus, a region of the brain that has long been a focus of schizophrenia research.

An information hub and relay center, the thalamus is central to working memory, sleep, consciousness and sensory-information processing.

"The oscillations produce an artificial signal that jams normal communication," Lisman says. "The part of the thalamus that is supposed to carry information about working memory couldn't do the task at all with these sleep-like delta waves. We suspect the abnormal delta oscillations seen in patients with schizophrenia are producing a similar jamming of normal signals."

Delta waves require a specific type of ion channel called a T-type Ca channel. These channels are of particular interest because they are one of the few types of ion channel implicated in schizophrenia by genetic studies. The next step, Lisman says, is to figure out what kind of agents could be used to block these channels.

"If you could block these channels, you could block these bad oscillations," he says. "That may have therapeutic value in patients."

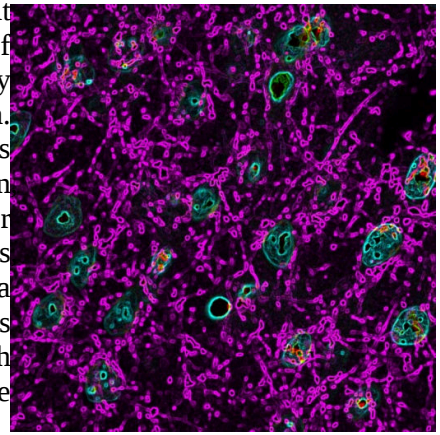
http://www.newyorker.com/tech/elements/the-brighter-side-of-rabies

The Brighter Side of Rabies

The rabies virus belongs, not coincidentally, to a group of viruses named for the Greek goddess of frenzy and rage.

By Patrick House

It enters the body at the site of a bite—often from a rabid dog or bat—and, using hook-like proteins that protrude from its outer shell, latches onto a nearby nerve cell. Once it has commandeered the cell, it treats the nervous system as a kind of interstate, hitchhiking from cell to cell by jumping the miniscule gaps between them. Within a matter of weeks or months, the virus reaches the brain, where it can cause agitation, confusion, and hydrophobia—a fear of water that results from an inability to swallow. (This, in turn, leads the saliva to become frothy, a hallmark of infection in mammals.) Rabies kills more than fifty thousand people each year; if left untreated, it has a mortality rate approaching a hundred per cent.



One of the world's most deadly pathogens is revolutionizing the study of the brain.

Nicholas Wall

Humans have a long tradition of turning things that harm us into things that help us. We made bears into hide coats, bred wolves into purse-sized dogs, and used botulinum toxin, the most acutely lethal poison on the planet, to smooth away crow's-feet. Eight years ago, the neuroscientist Ed Callaway and his colleagues at the Salk Institute, in La Jolla, California, added the rabies virus to this list, engineering their own strain in order to study the interplay of individual neurons

in the brain. Callaway and his team began with a vaccine form of the rabies virus that was missing the hook-making gene, rendering it unable to jump between cells. They equipped this inert virus with a single set of artificial hooks, allowing it to make exactly one jump—after which, Callaway told me, "it is stuck. It can't get out." Finally, they gave the virus a fluorescence gene borrowed from jellyfish; as it moved, it left behind a luminous wake.

Neuroscientists commonly talk about the brain as the Federal Aviation Administration does of regional airspace—as being composed of hubs, roughly defined by the number and type of incoming and outgoing connections. A complete flight map of the human brain would include about eighty billion airports and an estimated hundred trillion possible routes. Because the Salk team's modified rabies virus was restricted to only one jump, they were able to illuminate a tiny piece of the map—as if all incoming flights to, say, J.F.K. were suddenly and brightly aglow. Given enough of these pieces, it might one day be possible to compile a complete map of a mouse brain and, eventually, the human brain. The need for such maps is great. In an interview last year with the *Times*, the neurobiologist David van Essen likened today's brain mapping to eighteenth-century cartography—which is to say, mostly dark, likely wrong, and full of monsters. The ultimate goal, according to Thomas Insel, the director of the National Institute of Mental Health, is to "watch the brain do what it does at the speed of thought."

First, though, to improve the tools at hand. Ian Wickersham, a research scientist at Massachusetts Institute of Technology who helped Callaway engineer the modified rabies virus eight years ago, is now at work on another version. The original, Wickersham told me, "kills infected cells quite quickly: by about two weeks after infection, they're all either dead or in dire shape." This meant that the scientists had a limited time to observe the virus's movement in the brain. His goal, he said, is to make the rabies virus "innocuous, so infected neurons are completely healthy," which might enable scientists not only to see how individual neurons are connected but also to watch the connections form. In other labs, different modified viruses are being used to target cancer, enhance food safety, and cure certain forms of color blindness. A modified strain of H.I.V., Callaway noted, is often used in labs to transfer genes between organisms.

Nevertheless, Christof Koch, a neuroscientist at the Allen Institute for Brain Science, in Seattle, told me that despite the ubiquity of modified viruses in biomedical science—he estimates, for example, that one-third of research at Allen uses a virus, including the rabies virus, in some way—it is probably wrong to think that humanity has succeeded in taming them. In September, 2011, a few days after Callaway gave a talk in Boston about the next generation of rabies-based tools, a rabies outbreak started thirty-five hundred miles away, in Svalbard, a Norwegian archipelago halfway between the mainland and the North Pole. On September 12th, a woman in the capital city of Longyearbyen was bitten by a rabid Arctic fox. A local dog, wolf-like, killed the rabid fox but proceeded, dog-like, to lick the hands and faces of four people. The outbreak ended a month later in the deaths of eight reindeer and two foxes and the emergency vaccination of hundreds of residents. It took tens of thousands of years to domesticate wolves into dogs, but there are, of course, still wolves. "I wouldn't call viruses man's best friend quite yet," Koch said.

http://nyti.ms/1Et2QhP

Paternity Case for a New Jersey Mother of Twins Bears Unexpected Results: Two Fathers

A mother of twins was applying for public assistance in Passaic County, N.J., when she made the seemingly uncontroversial claim that one man was responsible for her progeny.

By BENJAMIN MUELLER MAY 7, 2015

The truth, it turns out, was not so simple.

In an unusual ruling in State Superior Court in Passaic County, Judge Sohail Mohammed found that egg and sperm had colluded to create a medical oddity, according to a report in The New Jersey Law Journal on Thursday. The man who the woman said was the father of her twins was deemed responsible for only one.

The other, the ruling revealed, was conceived during a previously undisclosed tryst that happened within a week of sexual intercourse with the man she claimed was the father.

It was a tangled web of love and biology that gave rise to what The Law Journal called a precedent-setting ruling, one of only a few of such cases across the country. The man originally described as the twins' father, identified in court documents only as A.S., will now have to pay child support only for the toddler who a DNA test showed was reliably his own.

The case took root when the mother, identified only as T.M., told the Passaic County Board of Social Services in the course of applying for benefits that A.S., her romantic partner, had fathered her twins, The Law Journal reported. The board, in turn, filed an application to establish his paternity and force him to pay child support for the twins, born in January 2013.

But the woman's claim slowly fell apart. She revealed in testimony that she had had sex with a second, unidentified man within a week of having sex with her romantic partner. A paternity test was ordered.

And when the results came back last November, a routine case became a curiosity destined for legal textbooks.

Judge Mohammed accepted the results after testimony from Karl-Hans Wurzinger, the laboratory director of the Identity Testing Division at Laboratory Corporation of America, The Law Journal reported. Dr. Wurzinger, who has published a study saying that one in 13,000 reported paternity cases involved twins with separate fathers, testified that this was one of those rare cases: The woman's twins were fertilized by different fathers during the same menstrual cycle.

Jennifer Wu, an obstetrician-gynecologist at Lenox Hill Hospital in Manhattan, called it a case of superfecundation, a rare phenomenon classically illustrated in medical textbooks with a black baby and a white baby who are twins.

A sperm can be viable for up to five days, Dr. Wu said. So if the mother in this case had sex with one of the men, ovulated, and then had sex with the other — all within the course of just under a week — one man's sperm could have fertilized one egg, while the other's fertilized another.

The phenomenon has become more common with the spread of assistive reproductive technologies, she said, as men in gay couples sometimes both contribute sperm to a pregnancy.

"That's why we're seeing it more often than we were in the past," Dr. Wu said, "when we were relying on nature and women who have more than one sexual partner in the same cycle around the time of ovulation."

http://bit.ly/1QydpZs

Autonomous truck cleared to drive on US roads for the first time

Automotive manufacturer Daimler unveiled a self-driving truck – the first to be cleared to drive on US roads

14:58 08 May 2015 by Aviva Rutkin

The next big thing in autonomous vehicles really is big. At a ceremony at the Hoover Dam last Wednesday, automotive manufacturer Daimler unveiled a self-driving truck – the first to be cleared to drive on US roads.

For the freight industry, the Inspiration Truck holds the promise of a future with fewer accidents, lower fuel costs and well-rested drivers.

Over the past few years, autonomous trucks have drawn the attention of companies that repeatedly use the same routes or encounter few people or other vehicles. Some farms use autonomous grain harvesters or planters. Mining company Rio Tinto has more than 50 self-driving vehicles hauling iron ore at a remote site in Western Australia. In Texas, the US military has been working on trucks that can navigate battle zones.

The Inspiration is different, designed to travel on the highway alongside regular cars and trucks. With clearance to drive on Nevada's highways, this could be big news for the trucking industry, which struggles to find drivers to do the exhausting work. If successful, other big self-driving vehicles could follow, such as garbage trucks or city buses.

Autonomous convoy

Autonomous trucks have a few potential advantages over their hands-on counterparts. For one, they could help cut fuel use, as they accelerate and decelerate more gently than a human driver might. Programming multiple trucks to travel in convoys would be beneficial, too: one truck could draft behind another, reducing air resistance and so using less fuel. The trucks would communicate, telling each other when to slow down or to speed up.

And the trucks could slot easily into an industry that has already embraced robotic help. In the port of Rotterdam in the Netherlands, containers are lifted off ships by robotic cranes and slotted into the right stacks with the help of automated trolleys. Last year, the Netherlands announced a five-year plan to prepare the country for vehicles like the Inspiration.

Proponents of self-driving vehicles also tout their safety benefits. According to one study, about 90 per cent of road accidents are caused by human error. Artificial intelligence takes those mistakes out of the equation.

"A car never gets tired. It doesn't have any emotions when it's driving home from a break-up with its girlfriend. It doesn't get drunk or old and slow," says Patrick Vogel at the Free University of Berlin in Germany.

The Inspiration trucks know how to stay in lane, change speed and avoid collisions. A camera mounted above the dashboard has a range of 100 metres which can recognize pavement markings and keeps the truck in its lane. Radar monitors the road up to 250 metres ahead to spot other vehicles and the truck also automatically complies with any speed limits.

Not totally driverless

But they are not totally driverless. A human driver still sits behind the wheel, ready to take over in case of a lane change or unexpected hazard.

With vehicles that are only partially autonomous, the safety benefits may not be so clear-cut, says Steven Shladover of the University of California at Berkeley.

"There is a risk that drivers will become overly dependent on the system, or that drivers may try to cheat a little bit and try to use the system in situations in which it was not intended to be used," he says. "If that happens, there could actually be safety problems."

Like other self-driving vehicles, the Inspiration truck is still years away from commercial release. Now that they're licensed, Daimler plans to conduct tests on Nevada's roads, collecting real-world data to help improve the truck further.

In the meantime, several issues still need to be addressed. It is not yet clear how insurance companies might cover self-driving vehicles, for instance, or where blame would be attributed in a road accident.

And the long-term implications of swapping out low-tech trucks for those using artificial intelligence are not yet clear - like what effect this will have on truckers' jobs or roadside businesses like motels and truck stops.

"Before it became clear that the technical issues could be addressed, these were academic exercises," says Peter Stone, a computer scientist at the University of Texas at Austin. "Now, they've become very real questions."

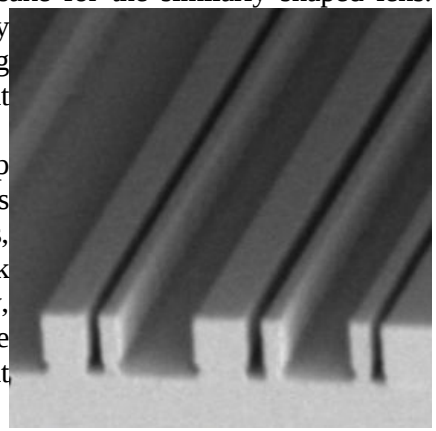
http://bit.ly/1zPNmIQ

Good-Bye to Curved Lens: New Lens Is Flat

It could one day be printed on flexible plastic for thin, bendable gadgets

By Prachi Patel | Apr 14, 2015

The gently curved lentil served as the namesake for the similarly shaped lens. Future cameras, however, may focus light by relying on flat lenses. Physicists are making major advancements with planar lenses that can scatter and bend rays of light, sans bulge.



As we dream of smartphones that could roll up or slip into a wallet, laboratory researchers have made inroads with flexible circuits, batteries and displays. The millimeters-thick camera lens, however, stands in the way, especially in cases where corrective lenses are necessary to overcome imperfections that would otherwise yield blurry images.

Microscopic image of lens **Courtesy Of Patrice Genevet, Federico Capasso and Francesco Aieta Harvard School of Engineering and Applied Sciences**

A leap ahead came in 2012, when physicist and engineer Federico Capasso and his colleagues at Harvard University introduced a rudimentary flat, ultrathin lens. Despite its lack of curvature, the glass sliver could focus light via microscopic silicon ridges densely and precisely arranged to bend incoming waves in specific, calculated directions (above). But the lens worked on wavelengths of only one color—and not precisely at that.

The latest rendition, detailed online in February in the journal Science, has moved beyond proof of concept: it perfectly focuses red, green and blue light, which can be combined to yield multicolor images. The team has since crafted a larger prototype, and it “works exactly like the prediction,” Capasso says. Such lenses could reduce the bulk and cost of photography, microscopy and astronomy equipment. And they could one day be printed on flexible plastic for thin, bendable gadgets. The scientists are in talks with Google and other technology companies. Such low-profile lenses would be useful for new kinds of compact, lightweight displays and imaging systems, says Bernard Kress, principal optical architect at Google[x].

The question is, If it doesn't look like a lentil, can it still be called a lens?