Infoteca's E-Journal

An Electronic Compilation of Scientific and Cultural Information by
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Michael Hart, inventor of the ebook, dies aged 64

Project Gutenberg began life in 1971 after Hart was given free use of University of Illinois computers

- guardian.co.uk, Thursday 8 September 2011 13.41 BST

Project Gutenberg founder Michael Hart, who created the first ever ebook after deciding on a whim to type the US Declaration of Independence into a computer, has died at home in Urbana, Illinois, aged 64.

In 1971, Hart was given extensive computer time by the operators of the Xerox Sigma V mainframe at the University of Illinois. Not wanting to waste the opportunity, he pondered carefully what to do with his time. "I happened to stop at our local IGA grocery store on the way. "We were just coming up on the American Bicentennial and they put faux parchment historical documents in with the groceries. So, as I fumbled through my backpack for something to eat, I found the US Declaration of Independence and had a lightbulb moment. I thought for a while to see if I could figure out anything I could do with the computer that would be more important than typing in the Declaration of Independence, something that would still be there 100 years later, but couldn't come up with anything, and so Project Gutenberg was born," he said in an interview in 2002.

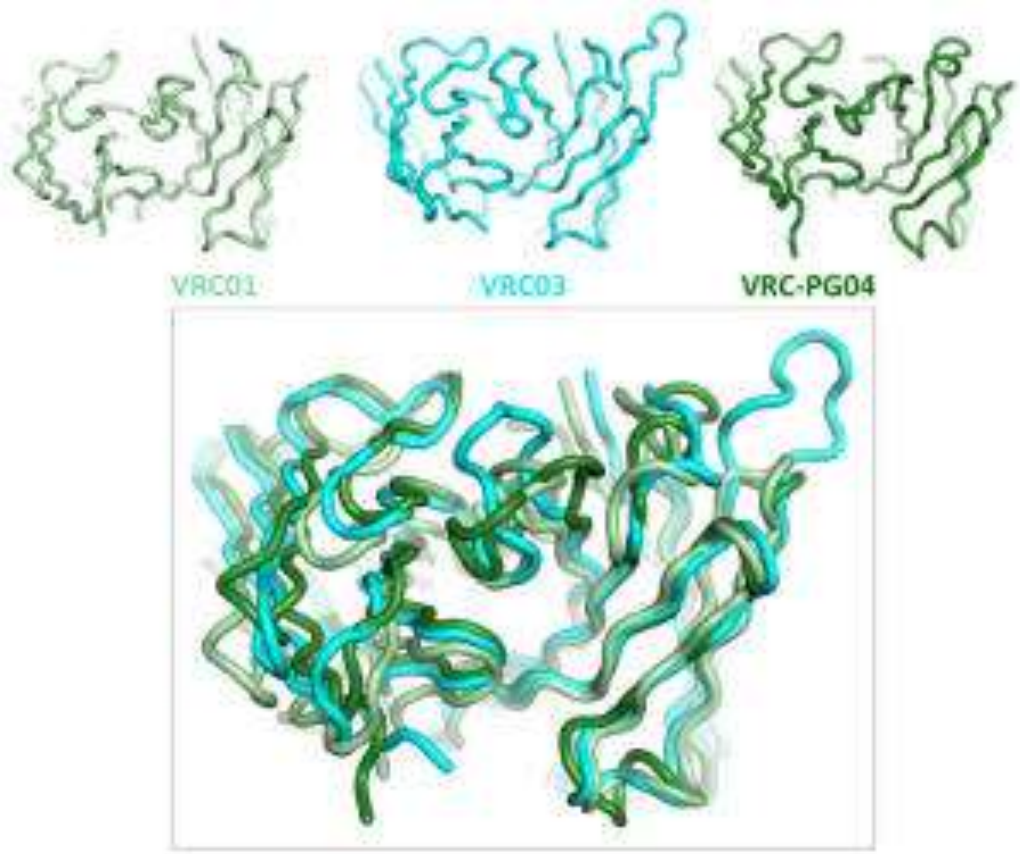
Today, Project Gutenberg is one of the largest collections of free ebooks in the world.

"What allowed me to think of this particular use for computers so long before anyone else did is the same thing that allows every other inventor to create their inventions: being at the right place, at the right time, with the right background. As Lermontov said in The Red Shoes: 'Not even the greatest magician in the world can pull a rabbit out of a hat if there isn't already a rabbit in it'," said Hart in 2002. "You have to remember that the internet had just gone transcontinental and this was one of the very first computers on it.

"Somehow I had envisioned the net in my mind very much as it would become 30 years later. I envisioned sending the Declaration of Independence to everyone on the net... all 100 of them... which would have crashed the whole thing, but luckily Fred Ranck stopped me, and we just posted a notice in what would later become comp.gen. I think about six out of the 100 users at the time downloaded it."

http://www.guardian.co.uk/books/2011/sep/08/michael-hart-inventor-ebook-dies

Route for Eliciting HIV-Neutralizing Antibodies Mapped



Top: These images show three antibodies' HIV-binding segments, which neutralize the virus. The VRC01 and VRC03 antibodies were found in the blood of an HIV-infected North American donor, while the VRC-PG04 antibody was found in the blood of an HIV-infected African donor. Bottom: Superimposing the HIV-binding segments of the three antibodies shows structural differences and similarities. The regions that are similar allow all three antibodies to bind to the same spot on the virus and to neutralize a high percentage of HIV strains from around the world. (Credit: NIAID VRC)

ScienceDaily (Aug. 12, 2011) — Researchers have traced in detail how certain powerful HIV neutralizing antibodies evolve, a finding that generates vital clues to guide the design of a preventive HIV vaccine, according to a study appearing in *Science* Express this week. The discoveries were made by a team led by the Vaccine Research Center (VRC) at the National Institute of Allergy and Infectious Diseases (NIAID), part of the National Institutes of Health.

"This elegant research brings us another step closer to an HIV vaccine and establishes a potent new technique for evaluating the human immune response to experimental vaccines, not only for HIV, but for pathogens generally," said NIAID Director Anthony S. Fauci, M.D.

The new findings build on last year's discovery reported by VRC scientists of three HIV antibodies, two of which could stop more than 90 percent of known global HIV strains from infecting human cells in the laboratory. Called VRC01, VRC02 and VRC03, these antibodies were found in blood donated for NIAID studies by an HIV-infected North American known as donor 45. In the new paper, scientists report discovering antibodies similar to VRC01 in the blood of two HIV-infected Africans known as donor 74 and donor 0219.

The researchers further discovered that these VRC01-like antibodies all bind to the same spot on HIV in the same way. This suggests that an HIV vaccine should contain a protein replica of this spot, known as the CD4 binding site, to elicit antibodies as powerful as VRC01, according to the researchers. The CD4 binding site is one of the few parts of the continuously mutating virus that stays the same across HIV variants worldwide, and the virus uses this site to attach to the cells it infects.

The scientists previously found that the genes for VRC01-like antibodies undergo an unusually high number of mutations -- 70 to 90 -- between the first draft that codes for a weak antibody and the final version that codes for an antibody that can neutralize HIV. These genes lie in the DNA of immune cells called B cells.

"To make a vaccine that elicits VRC01-like antibodies, we will need to coach B cells to evolve their antibody genes along one of several pathways, which we have now identified, from infancy to a mature, HIV-fighting form," said VRC Director Gary J. Nabel, M.D., Ph.D.

To guide B cells along this extended evolutionary pathway, the scientists first needed to map the route. They began by turning to an existing technology to sequence the collection of B-cell genes that code for all the antibodies created by a person's immune system. This study marks the first time this technology, called deep sequencing, has been used to track the evolution of the antibody response to HIV at the genetic level. The NIH researchers then devised sophisticated bioinformatics techniques to decipher the large library of genetic data produced by deep sequencing.

"We found a way to read the books, or genes, in this library by defining unique characteristics of VRC01-like antibodies," said Peter Kwong, Ph.D., chief of the VRC's structural biology section and co-principal investigator of the study.

Based on their discovery of the common structure and genetic origin of the VRC01-like antibodies, the scientists devised strategies for scanning the B-cell DNA libraries of donor 45 and donor 74. From hundreds of thousands of antibody genes, the scientists first identified thousands that code for VRC01-like antibodies and then sorted these genes into family trees showing their evolution from their earliest stage into mature forms. The genes that coded for HIV neutralizing antibodies grouped together on the same branches of the trees.

Next, the researchers focused on the gene segment that codes for the part of the VRC01-like antibody that attaches to and neutralizes HIV. Examining this sequence in the genes of the newfound relatives of VRC01 revealed how the sequence changed step by step along one of a few clear paths from its original state into a mature form. A vaccine that elicits VRC01-like antibodies would need to coax the B-cell DNA of immature antibodies to evolve along one of these pathways.

The scientists now aim to create proteins they can deliver through a vaccine to serve as signposts that direct the development of B-cell DNA to produce VRC01-like antibodies.

The new research has far-reaching implications for vaccine development. "As we develop and test new HIV vaccines, it will be possible to analyze not just antibodies in the blood, but also the specific B-cell genes that are responsible for producing antibodies against HIV," said John R. Mascola, M.D., deputy director of the VRC and co-principal investigator of the study. "This information will indicate whether an investigational HIV vaccine in a preclinical or clinical trial is heading in the right direction."

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by NIH/National Institute of Allergy and Infectious Diseases.

Journal Reference:

1. Xueling Wu, Tongqing Zhou, Jiang Zhu, Baoshan Zhang, Ivelin Georgiev, Charlene Wang, Xuejun Chen, Nancy S. Longo, Mark Louder, Krisha McKee, Sijy O'Dell, Stephen Perfetto, Stephen D. Schmidt, Wei Shi, Lan Wu, Yongping Yang, Zhi-Yong Yang, Zhongjia Yang, Zhenhai Zhang, Mattia Bonsignori, John A. Crump, Saidi H. Kapiga, Noel E. Sam, Barton F. Haynes, Melissa Simek, Dennis R. Burton, Wayne C. Koff, Nicole Doria-Rose, Mark Connors, NISC Comparative Sequencing Program, James C. Mullikin, Gary J. Nabel, Mario Roederer, Lawrence Shapiro, Peter D. Kwong, and John R. Mascola. Focused evolution of HIV-1 neutralizing antibodies revealed by crystal structures and deep sequencing. *Science*, 11 August 2011 DOI: 10.1126/science.1207532

http://www.sciencedaily.com/releases/2011/08/110811142812.htm

Smartphone jiggles reveal your private data

- 16 August 2011 by Jacob Aron
- Magazine issue 2825.

Tapped for information (Image: M. Docher/Plainpicture)

THE slight movements of your smartphone every time you tap on the touchscreen could be giving away what you are typing.

Eavesdropping on a computer user's keyboard input is called keylogging. Often the culprit is software that runs invisibly, tracking what you type and reporting back to the attacker who installed it - making it easy to steal passwords or bank details.

Keylogging is much harder to pull off on smartphones because most mobile operating systems allow only whatever app is on screen to access what you are typing, says security researcher Hao Chen of the University of California, Davis.

However, Chen and his colleague Liang Cai have got around that hurdle and created a keylogger that runs on Android smartphones. It uses the phone's motion sensors to detect vibrations from tapping the screen. Since mobile operating systems do not treat the motion-sensor output as private or in need of protection, it presents a target for hackers wanting to create an innocent-looking app that secretly monitors phone users.

Chen's keylogger does not have to be visible on screen to sense the phone's horizontal and vertical movements. It calculates which key of the virtual keyboard the user has tapped based on how the phone

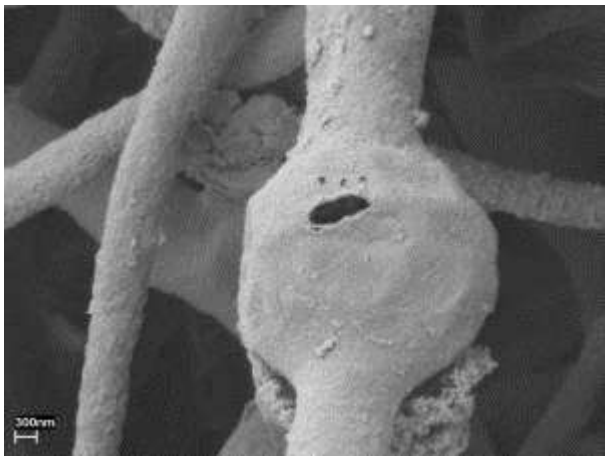
jiggles in response. The app correctly guesses over 70 per cent of keystrokes on a virtual numerical keypad like those in calculator apps, the pair say.

Chen believes the technique will work on a full alphanumeric keyboard, too, but says that it will probably be less accurate. "However, we expect accuracy to be higher on a tablet device," he says, because the tablet's larger dimensions would accentuate its movements as the user taps the screen. He will present the work at the HotSec conference in San Francisco, California, next week.

Chen says criminals could already be using touchscreen keyloggers, though he hasn't seen one yet. Martin Lee of the computer security firm Symantec says the keylogger is a neat idea, but he points out that there are much simpler ways to get at private information, such as phishing attacks that fool people into revealing their details. Still, he warns that mobile-phone malware is an emerging threat. "I'm sure this isn't the last time we'll see a phone system being used against its owner," he says.

http://www.newscientist.com/article/mg21128255.200-smartphone-jiggles-reveal-your-private-data.html

Hidden Soil Fungus, Now Revealed, Is in a Class All Its Own



SEM (scanning electron microscopy) image of fixed culture. A swelling has cracked and looks like a face. Scale: 300 nm (Credit: Anna Rosling & Karelyn Cruz Martinez)

ScienceDaily (Aug. 11, 2011) — A type of fungus that's been lurking underground for millions of years, previously known to science only through its DNA, has been cultured, photographed, named and assigned a place on the tree of life.

Researchers say it represents an entirely new class of fungi: the *Archaeorhizomycetes*. Like the discovery of a weird type of aquatic fungus that made headlines a few months ago, this finding offers a glimpse at the rich diversity of microorganisms that share our world but remain hidden from view.

The fungal phenomenon, brought to light by researchers at the University of Michigan, the Swedish University of Agricultural Sciences, the Imperial College London and Royal Botanic Gardens and the University of Aberdeen, is described in the Aug. 12 issue of the journal *Science*.

Although unseen until recently, the fungus was known to be extremely common in soil. Its presence was detected in studies of environmental DNA -- genetic material from a living organism that is detected in bulk environmental samples, such as samples of the soil or water in which the organism lives.

"You couldn't really sample the soil without finding evidence of it," said Timothy James, a U-M assistant professor of ecology and evolutionary biology and an assistant curator at the university's herbarium. "So people really wanted to know what it looks like."

That became possible thanks to the work of the Swedish researchers, led by mycologist Anna Rosling. The researchers were studying mycorrhizae -- fungi that colonize plant roots -- when they discovered that some root tips harbored not only the mycorrhizae they were interested in, but also an unfamiliar fungus.

"When culturing mycorrhizal fungi from coniferous roots we were exited to find that one of the cultures represented this unfamiliar fungus," said Anna Rosling.

Later the culture was identified as a member of Soil Clone Group 1 (SCG1), a ubiquitous but enigmatic lineage known only from environmental DNA. It's not especially impressive to look at, James concedes: "It doesn't make some crazy structure that nobody's ever seen." But simply seeing and photographing a form of life that's been invisible until now is cause for excitement.

Having in hand a member of the elusive fungal group, the Swedish scientists and their collaborators have been able to study the group in more detail than ever before possible, using electron microscopy, DNA sequencing and in vitro growth studies to characterize it. The fungus they cultured is a slow-growing form that produces none of the typical aerial or aquatically dispersed spores most fungi typically reproduce with, suggesting it seldom if ever sees the light of day.

"By finding that it is slow growing and only produces spores in the soil, we can provide an explanation for why it has taken so long to be cultured," James said. The researchers also performed experiments aimed at understanding how the fungus, dubbed *Archaeorhizomyces finlayi*, interacts with the environment and with other organisms.

"We don't have any evidence that it's pathogenic; we don't have any evidence that it's mutualistic and doing anything beneficial for the plant," James said. "It's a little bit of a boring fungus." It may, however, help break down and recycle dead plants, a common -- and extremely important -- job for fungi. Hints of this role come from the observation that *A. finlayi* grows in the lab if provided with food in the form of glucose or cellulose (the main structural component of plant cell walls).

"Because it is so common in the soil, it must be very successful at what it does, and that role must be ecologically relevant," Rosling said.

Now that the researchers have ruled out some typical fungal roles -- such as pathogen, benign endophyte, and member of a mycorrhizal association -- they hope to find out through additional experiments exactly what role the fungus does play in nature and how it interacts with plants and other fungi.

"At this point we're still in the early stages of understanding what it's doing out there," James said.

Whether *A. finlayi* turns out to be beneficial or detrimental to the plants or microbes it interacts with, it's sure to contribute to understanding the diverse array of fungi in the world.

Though environmental DNA of SCG1 had been collected and reported in more than 50 previous studies, the type of DNA collected in the past didn't lend itself to analyses that would definitively pinpoint the group's position on the tree of life.

"Now that we have the culture, we can sequence almost any gene we want, so that's what we've done," James said.

The resulting information, combined with DNA data from the previous studies, revealed that *A. finlayi* belongs in an eclectic subphylum known as Taphrinomycotina, other members of which include the yeast Schizosaccharomyces, often used in studies of cell biology and evolution, and Pneumocystis, which can cause pneumonia in people with weakened immune systems, such as those who have cancer or HIV/AIDS or are undergoing treatment with immune-suppressing drugs.

In addition to James and Rosling, who is currently a visiting research associate at Indiana University, the paper's authors include Filipa Cox of the Imperial College London and Royal Botanic Gardens; Karelyn Cruz-Martinez, Katarina Ihrmark, Björn Lindahl and Audrius Menkis of the Swedish University of Agricultural Sciences; and Gwen-Aëlle Grelet of the University of Aberdeen.

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Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by University of Michigan.

Journal Reference:

1. A. Rosling, F. Cox, K. Cruz-Martinez, K. Ihrmark, G.-A. Grelet, B. D. Lindahl, A. Menkis, T. Y. James. Archaeorhizomycetes: Unearthing an Ancient Class of Ubiquitous Soil Fungi. *Science*, 2011; 333 (6044): 876 DOI: 10.1126/science.1206958

http://www.sciencedaily.com/releases/2011/08/110811142819.htm

Face recognition technology fails to find UK rioters

- 18 August 2011 by Niall Firth
- Magazine issue 2826.

Police want to identify these men (Image: Metropolitan Police/AP/PA)

THE response was as aggressive and swift as the riots themselves. Within a few hours of the worst of last week's looting across London and other English cities, attempts were being made to use CCTV footage to track down the individuals who had plundered shops and destroyed buildings.

But those raised on a diet of TV police dramas who expected crack law enforcement teams to simply plug the footage into a computer and then print out a list of suspects are going to be disappointed. The poor quality of most CCTV footage makes it almost impossible to trust standard automated facial recognition techniques.

One of the most common methods used to help identify an individual from camera footage is photoanthropometry, which uses "proportionality indices" to compare a picture of a suspect on a police database, say, with a CCTV image. Key points on a person's face - such as the chin, edge of the nose, or centre of the top lip - are marked and the distance between them measured. Someone experienced with this technique can then judge whether the two faces match.

Reuben Moreton from the London Metropolitan Police's Digital and Electronic Forensic Service tested the techniques on poor quality, low-resolution footage of 13 volunteers. It produced "chaotic, inconsistent results" (*Forensic Science*, DOI: 10.1016/j.forsciint.2011.06.023). The lack of facial detail reduced the precision of the PI measurements so that individuals with similar PIs could easily be confused with one another.

Imperfect CCTV and poor- quality images can easily thwart more advanced, automated techniques too, says Lyndon Smith at the Machine Vision Laboratory of the University of the West of England, Bristol, UK.

"There is an inherent reliability problem in conventional face recognition systems," he says. "Changes in lighting, image quality, changing background and orientation - even make-up can fool them."

Smith's group is working on a system called Photoface that he believes could help. The system takes a number of 2D images of someone's face and then stitches them together into a 3D model in which the lighting can be manipulated and the face can be viewed from different angles. He envisages Photoface being used on

CCTV footage fed to a police control room. "This is a system that could help with the identification of people in unusual situations or low light," Smith says.

Graham Cluley, senior technology consultant at IT security firm Sophos, agrees that current systems are not up to the task. "This is not *CSI Miami*," he says. "Computers can't do the things you see on TV shows."

While a Metropolitan police source told *New Scientist* that face recognition technology is being used in some cases, it is only effective for face-on shots. It's far more useful, he says, to post CCTV images of suspected rioters on the Met's Flickr account, and then invite the public to comb through the images and point out suspects they recognise. "We can get a JPEG in front of a million people in 2 minutes. No computer system can match that at the moment."

Some digital vigilantes believe face recognition technology will provide the answer. A group of programmers have formed the Google Group "London Riots Facial Recognition". They won't discuss their techniques, but told *New Scientist*: "We're just a bunch of computer programmers who want to use technology to try and help the situation."

Make a match on Facebook

WHILE CCTV images are tricky to analyse effectively, facial recognition software can still be a powerful tool.

At the Black Hat conference in Las Vegas last month Alessandro Acquisti of Carnegie Mellon University in Pittsburgh, Pennsylvania, demonstrated how easy it is to match anonymous photos of people to their Facebook profile pictures.

Around 100 student volunteers were asked to peer into a webcam. After just 3 seconds of scanning, off-the-shelf face recognition software linked 31 per cent of the students to their Facebook profile. He also showed it was possible to put a name to the faces of people on a dating website by cross-referencing their pictures with Facebook.

http://www.newscientist.com/article/mg21128266.000-face-recognition-technology-fails-to-find-uk-rioters.html

Supernovae Parents Found: Clear Signatures of Gas Outflows from Stellar Ancestors

Type Ia supernovae are violent stellar explosions whose brightness is used to determine distances in the universe. (Credit: Image courtesy of Carnegie Institution)

ScienceDaily (Aug. 11, 2011) — Type Ia supernovae are violent stellar explosions whose brightness is used to determine distances in the universe. Observing these objects to billions of light years away has led to the discovery that the universe is expanding at an accelerating rate, the foundation for the notion of dark energy. Although all Type Ia supernovae appear to be very similar, astronomers do not know for certain how the explosions take place and whether they all share the same origin. Now, a team of researchers has examined new and detailed observations of 41 of these objects and concluded that there are clear signatures of gas outflows from the supernova ancestors, which do not appear to be white dwarfs.

The research is published in the August 12 issue of *Science*.

The widely accepted theory is that Type Ia supernovae are thermonuclear explosions of a white dwarf star in a close binary system. There are two competing scenarios for supernova ancestry. In the so-called single-degenerate model, the accompanying star in the binary is a main-sequence star or evolved star. In the competing double-degenerate model, the companion is another white dwarf -- a very dense star in its final evolutionary stage.

"Because we don't know what the things blowing up actually are, we don't quite understand why they should all be so similar," explained coauthor Josh Simon of the Carnegie Observatories. "That raises the possibility that Type Ia supernovae that occurred 7 billion years ago -- the ones that allow us to measure the repulsive force we call dark energy -- might be different in some subtle way from the ones occurring now. Maybe they are a little bit brighter than the ancient ones, for example."

Mark Phillips, also from Carnegie added, "We wanted to get a better understanding of what the stars look like before the explosion to help determine the origin of their brightness. That information will allow us to be sure that there are no errors of this type distorting the dark energy measurements."

The astronomers looked for absorption by sodium atoms in the spectrum of each of the 41 supernovae. Sodium is a telltale sign of cool, neutral gas in the vicinity of the explosion. By measuring the speed of the sodium clouds using the Doppler shift, they determined that the majority of the supernovae show sodium gas moving away from the explosion site and toward Earth.

"If the star system originally contained two white dwarfs before the supernova, then there shouldn't be any sodium," remarked Carnegie's Nidia Morrell. "The fact that we detected the sodium shows that one of the stars must not have been a white dwarf."

The astronomers ruled out other possible sources of the sodium absorption features including interstellar clouds or a galactic-scale wind blown by the host galaxy.

"The low velocities and narrowness of the features suggest that the absorption is from material very close to the supernova that was ejected by the parent system before the explosion. Typically, gas with these characteristics is attributed to the stellar wind blown by red giant companion stars, not white dwarfs," concluded Simon.

The finding is an important first step toward understanding the details of how Type Ia supernovae explode and the origin of their immense luminosity.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by Carnegie Institution.

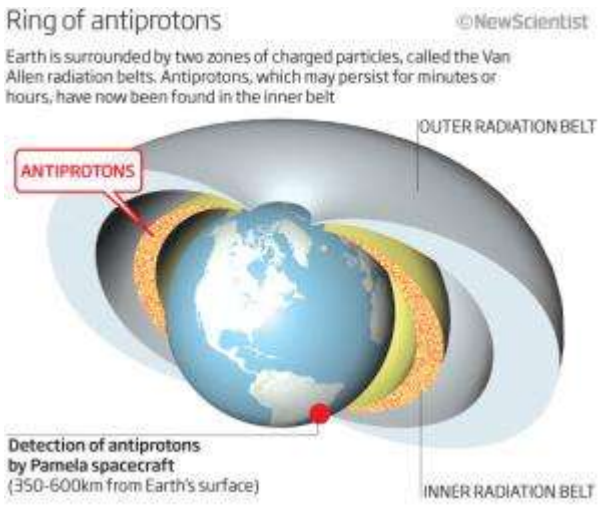
Journal Reference:

1. A. Sternberg, A. Gal-Yam, J. D. Simon, D. C. Leonard, R. M. Quimby, M. M. Phillips, N. Morrell, I. B. Thompson, I. Ivans, J. L. Marshall, A. V. Filippenko, G. W. Marcy, J. S. Bloom, F. Patat, R. J. Foley, D. Yong, B. E. Penprase, D. J. Beeler, C. A. Prieto, G. S. Stringfellow. Circumstellar Material in Type Ia Supernovae via Sodium Absorption Features. *Science*, 2011; 333 (6044): 856 DOI: 10.1126/science.1203836

http://www.sciencedaily.com/releases/2011/08/110811142814.htm

Antiproton ring found around Earth

- 04 August 2011 by Hazel Muir
- Magazine issue 2824.



Ring of antiprotons

ANTIPROTONS appear to ring the Earth, confined by the planet's magnetic field lines. The antimatter, which may persist for minutes or hours before annihilating with normal matter, could in theory be used to fuel ultra-efficient rockets of the future.

Charged particles called cosmic rays constantly rain in from space, creating a spray of new particles - including antiparticles - when they collide with particles in the atmosphere. Many of these become trapped inside the Van Allen radiation belts, two doughnut-shaped zones around the planet where charged particles spiral around the Earth's magnetic field lines.

Satellites had already discovered positrons - the antimatter partners of electrons - in the radiation belts. Now a spacecraft has detected antiprotons, which are nearly 2000 times as massive.

Heavier particles take wider paths when they spiral around the planet's magnetic lines, and weaker magnetic field lines also lead to wider spirals. So relatively heavy antiprotons travelling around the weak field lines in the outer radiation belt were expected to take loops so big they would quickly get pulled into the lower atmosphere, where they would annihilate with normal matter. The inner belt was thought to have fields strong enough to trap antiprotons, and indeed that is where they have been found.

Piergiorgio Picozza from the University of Rome Tor Vergata, Italy, and colleagues detected the antiprotons using PAMELA, a cosmic-ray detector attached to a Russian Earth-observation satellite. The spacecraft flies through the Earth's inner radiation belt over the south Atlantic.

Between July 2006 and December 2008, PAMELA detected 28 antiprotons trapped in spiralling orbits around the magnetic field lines sprouting from the Earth's south pole (*Astrophysical Journal Letters*, DOI:

10.1088/2041-8205/737/2/l29). PAMELA samples only a small part of the inner radiation belt, but antiprotons are probably trapped throughout it. "We are talking about of billions of particles," says team member Francesco Cafagna from the University of Bari in Italy.

"I find it very interesting to note that the Earth's magnetic field works a little bit like the magnetic traps that we are using in the lab," says Rolf Landua at the CERN particle physics laboratory near Geneva, Switzerland. There, researchers have been trying to trap antimatter for ever longer periods to compare its behaviour with that of normal matter.

Alessandro Bruno, another team member from Bari, says antimatter in the Earth's radiation belts might one day be useful for fuelling spacecraft. Future rockets could be powered by the reaction between matter and antimatter, a reaction that produces energy even more efficiently than nuclear fusion in the sun's core.

"This is the most abundant source of antiprotons near the Earth," says Bruno. "Who knows, one day a spacecraft could launch then refuel in the inner radiation belt before travelling further."

Millions or billions of times as many antiprotons probably ring the giant planets.

http://www.newscientist.com/article/mg21128245.500-antiproton-ring-found-around-earth.html

Hydrogen-Powered Symbiotic Bacteria Found in Deep-Sea Hydrothermal Vent Mussels

At the black smokers in 3000 meter depth, there live exceptional symbiotic communities. (Credit: Credit: MARUM)

ScienceDaily (Aug. 11, 2011) — The search for new energy sources to power humankind's increasing needs is currently a topic of immense interest. Hydrogen-powered fuel cells are considered one of the most promising clean energy alternatives. While intensive research efforts have gone into developing ways to harness hydrogen energy to fuel our everyday lives, a natural example of a living hydrogen-powered 'fuel cell' has gone unnoticed.

During a recent expedition to hydrothermal vents in the deep sea, researchers from the Max Planck Institute of Marine Microbiology and the Cluster of Excellence MARUM discovered mussels that have their own on-board 'fuel cells', in the form of symbiotic bacteria that use hydrogen as an energy source. Their results, which appear in the current issue of *Nature*, suggest that the ability to use hydrogen as a source of energy is widespread in hydrothermal vent symbioses.

Deep-sea hydrothermal vents are formed at mid-ocean spreading centers where tectonic plates drift apart and new oceanic crust is created by magma rising from deep within planet Earth. When seawater interacts with hot rock and rising magma, it becomes superheated, dissolving minerals out of Earth's crust. At hydrothermal vents, this superheated energy-laden seawater gushes back out into the ocean at temperatures of up to 400 degrees Celsius, forming black smoker chimneys where it comes into contact with cold deep-sea water. These hot fluids deliver inorganic compounds such as hydrogen sulfide, ammonium, methane, iron and hydrogen to the oceans. The organisms living at hydrothermal vents oxidize these inorganic compounds to gain the energy needed to create organic matter from carbon dioxide. Unlike on land, where sunlight provides the energy for photosynthesis, in the dark depths of the sea, inorganic chemicals provide energy for life in a process called chemosynthesis.

When hydrothermal vents were first discovered more than 30 years ago, researchers were astounded to find that they were inhabited by lush communities of animals such as worms, mollusks and crustaceans, most of which were completely unknown to science. The first to investigate these animals quickly realized that the

key to their survival was their symbiotic association with chemosynthetic microbes, which are the on-board power plants for hydrothermal vent animals. Until now, only two sources of energy were known to power chemosynthesis by symbiotic bacteria at hydrothermal vents: Hydrogen sulfide, used by sulfur-oxidizing symbionts, and methane, used by methane-oxidizing symbionts. "We have now discovered a third energy source" says Nicole Dubilier from the Max Planck Institute of Marine Microbiology in Bremen, who led the team responsible for this discovery.

The discovery began at the Logatchev hydrothermal vent field, at 3000 m depth on the Mid-Atlantic Ridge, an undersea mountain range halfway between the Caribbean and the Cape Verde Islands. The highest hydrogen concentrations ever measured at hydrothermal vents were recorded during a series of research expeditions to Logatchev. According to Jillian Petersen, a researcher with Nicole Dubilier, "our calculations show that at this hydrothermal vent, hydrogen oxidation could deliver seven times more energy than methane oxidation, and up to 18 times more energy than sulfide oxidation."

In the gills of the deep-sea mussel Bathymodiolus puteoserpentis, one of the most abundant animals at Logatchev, the researchers discovered a sulfur-oxidizing symbiont that can also use hydrogen as an energy source. To track down these hydrogen-powered on-board 'fuel cells' in the deep-sea mussels, the researchers deployed two deep-sea submersibles, MARUM-QUEST from MARUM at the University of Bremen, and KIEL 6000 from IFM-GEOMAR in Kiel. With the help of these remotely-driven submersibles, they sampled mussels from sites kilometers below the sea surface. Their ship-board experiments with live samples showed that the mussels consumed hydrogen. Once the samples were back in the laboratory on land, they were able to identify the mussel symbiont hydrogenase, the key enzyme for hydrogen oxidation, using molecular techniques.

The mussel beds at Logatchev form a teeming expanse that covers hundreds of square meteres and contains an estimated half a million mussels. "Our experiments show that this mussel population could consume up to 5000 liters of hydrogen per hour" according to Frank Zielinski, a former doctoral student in Nicole Dubilier's Group in Bremen, who now works as a post-doctoral researcher at the Helmholtz Centre for Environmental Research in Leipzig. The deep-sea mussel symbionts therefore play a substantial role as the primary producers responsible for transforming geofuels to biomass in these habitats. "The hydrothermal vents along the mid-ocean ridges that emit large amounts of hydrogen can therefore be likened to a hydrogen highway with fuelling stations for symbiotic primary production" says Jillian Petersen.

Even the symbionts of other hydrothermal vent animals such as the giant tubeworm Riftia pachyptila and the shrimp Rimicaris exoculata have the key gene for hydrogen oxidation, but remarkably, this had not been previously recognized. "The ability to use hydrogen as an energy source seems to be widespread in these symbioses, even at hydrothermal vent sites with low amounts of hydrogen" says Nicole Dubilier.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by Max-Planck-Gesellschaft.

Journal Reference:

1. Jillian M. Petersen, Frank U. Zielinski, Thomas Pape, Richard Seifert, Cristina Moraru, Rudolf Amann, Stephane Hourdez, Peter R. Girguis, Scott D. Wankel, Valerie Barbe, Eric Pelletier, Dennis Fink, Christian Borowski, Wolfgang Bach, Nicole Dubilier. Hydrogen is an energy source for hydrothermal vent symbioses. *Nature*, 2011; 476 (7359): 176 DOI: 10.1038/nature10325

http://www.sciencedaily.com/releases/2011/08/110810132832.htm

Did quake or tsunami cause Fukushima meltdown?

- 16:50 19 August 2011 by Andy Coghlan

Facts found (Image: TEPCO)

Japan's nuclear safety agency today rejected a claim in British newspaper *The Independent* that the earthquake itself, not the subsequent tsunami, destroyed cooling systems leading to meltdowns at the Fukushima Daiichi nuclear plant.

"It is not correct," a spokesman for Japan's nuclear safety watchdog, the Nuclear and Industrial Safety Agency (NISA), told *New Scientist*.

The claim made in *The Independent* contradicts public reassurances from the Tokyo Electric Power Company (TEPCO) , the company that owns the plant, that its facility stood up to the quake as it should, but was overwhelmed by the tsunami. If the quake did cause the damage, it could call into question the resilience of TEPCO's other nuclear installations in Japan. TEPCO and Japan's nuclear industry as a whole have been criticised for attempting to cover up accidents in the past.

The paper reported that workers said they had seen cooling-water pipes bursting as they were evacuating from the nuclear plant following the quake at 2.52 pm on 11 March – before the tsunami struck about 45 minutes later.

It also quoted nuclear engineers who concluded from data released by TEPCO that coolant systems must have failed shortly after the quake.

Meltdown inevitable

"There was already so much damage to the cooling system that a meltdown was inevitable," Mitsuhiko Tanaka, a former nuclear plant designer, is quoted as saying.

Tanaka said that according to TEPCO's own data, emergency water-circulation equipment started up automatically shortly after the quake. "This only happens when there is a loss of coolant," he told *The*

Independent. Likewise, between 3.04 pm and 3.11 pm, water sprayers in the containment vessel of reactor unit 1 were activated; Tanaka says this is a failsafe for when all other cooling systems have failed.

So by the time the tsunami struck at 3.37 pm, "the plant was already on its way to melting down", says the newspaper.

The Independent also quotes the results of a NISA visit to Fukushima nine days before the quake. It says that NISA warned TEPCO about its failure to inspect critical machinery at the plant, including recirculation pumps.

No damage

NISA's spokesman said that the agency's press release about its visit on 2 March may have been misunderstood. "There was no damaged piping in the Fukushima Daiichi nuclear power plant, as claimed in the article," he said.

What the press release actually said was that some of TEPCO's periodic equipment checks were behind schedule, said the spokesman.

NISA also rejected the central claim of the article: that the quake, not the tsunami, caused the critical damage leading to meltdown. "It is not correct," said the spokesman. "Before the tsunami hit, the cooling system was operated by diesel generators in the plant [to compensate for] a loss of external power sources after the earthquake."

So not until the tsunami swept away the diesel generators did the cooling system fail, ultimately causing meltdowns.

Viennese backup

NISA's version of events was backed up yesterday by the International Atomic Energy Agency in Vienna, Austria, which sent a fact-finding mission to Fukushima in May.

An IAEA spokesman said that a report from the mission – led by Mike Weightman the UK's chief inspector of nuclear installations – contains detailed accounts of the failure of cooling systems in the early hours of the disaster which challenge the idea that the quake caused the damage, as claimed in *The Independent*.

Meanwhile, TEPCO said on Wednesday that overall radiation released from the three damaged Fukushima reactors is now a 10-millionth of peak levels recorded on 15 March, just after the accident.

Wednesday also saw reactor 3 of the Tomari nuclear plant in Hokkaido become the first of Japan's nuclear installations since the disaster to resume full commercial operation.

http://www.newscientist.com/article/dn20811-did-quake-or-tsunami-cause-fukushima-meltdown.html

What Students Don't Know

August 22, 2011

CHICAGO -- For a stranger, the main library at the University of Illinois at Chicago can be hard to find. The directions I got from a pair of clerks at the credit union in the student center have proven unreliable. I now find myself adrift among ash trees and drab geometric buildings.

Finally, I call for help. Firouzeh Logan, a reference librarian here, soon appears and guides me where I need to go. Several unmarked pathways and an escalator ride later, I am in a private room on the second floor of the library, surrounded by librarians eager to answer my questions.

Most students never make it this far.

This is one of the sobering truths these librarians, representing a group of Illinois universities, have learned over the course of a two-year, five-campus ethnographic study examining how students view and use their campus libraries: students rarely ask librarians for help, even when they need it. The idea of a librarian as an academic expert who is available to talk about assignments and hold their hands through the research process is, in fact, foreign to most students. Those who even have the word "librarian" in their vocabularies often think library staff are only good for pointing to different sections of the stacks.

The ERIAL (Ethnographic Research in Illinois Academic Libraries) project -- a series of studies conducted at Illinois Wesleyan, DePaul University, and Northeastern Illinois University, and the University of Illinois's Chicago and Springfield campuses -- was a meta-exercise for the librarians in practicing the sort of deep research they champion. Instead of relying on surveys, the libraries enlisted two anthropologists, along with their own staff members, to collect data using open-ended interviews and direct observation, among other methods.

The goal was to generate data that, rather than being statistically significant yet shallow, would provide deep, subjective accounts of what students, librarians and professors think of the library and each other at those five institutions. The resulting papers are scheduled to be published by the American Library Association this fall, under the title: "Libraries and Student Culture: What We Now Know."

One thing the librarians now know is that their students' research habits are worse than they thought.

At Illinois Wesleyan University, "The majority of students -- of all levels -- exhibited significant difficulties that ranged across nearly every aspect of the search process," according to researchers there. They tended to overuse Google and misuse scholarly databases. They preferred simple database searches to other methods of discovery, but generally exhibited "a lack of understanding of search logic" that often foiled their attempts to find good sources.

However, the researchers did not place the onus solely on students. Librarians and professors are also partially to blame for the gulf that has opened between students and the library employees who are supposed to help them, the ERIAL researchers say. Librarians tend to overestimate the research skills of some of their students, which can result in interactions that leave students feeling intimidated and alienated, say the ERIAL researchers. Some professors make similar assumptions, and fail to require that their students visit with a librarian before embarking on research projects. And both professors and librarians are liable to project an idealistic view of the research process onto students who often are not willing or able to fulfill it.

"If we quietly hope to convert all students to the liberal ideals of higher education, we may miss opportunities to connect with a pragmatic student body," wrote Mary Thill, a humanities librarian at Northeastern Illinois. "… By financial necessity, many of today's students have limited time to devote to their research." Showing students the pool and then shoving them into the deep end is more likely to foster despair than self-reliance, Thill wrote. "Now more than ever, academic librarians should seek to 'save time for the reader.' "

Before they can do that, of course, they will have to actually get students to ask for help. That means understanding why students are not asking for help and knowing what kind of help they need, say the librarians.

"This study has changed, profoundly, how I see my role at the university and my understanding of who our students are," says Lynda Duke, an academic outreach librarian at Illinois Wesleyan. "It's been life-changing, truly."

Exploding the 'Myth of the Digital Native'

The most alarming finding in the ERIAL studies was perhaps the most predictable: when it comes to finding and evaluating sources in the Internet age, students are downright lousy.

Only seven out of 30 students whom anthropologists observed at Illinois Wesleyan "conducted what a librarian might consider a reasonably well-executed search," wrote Duke and Andrew Asher, an anthropologist at Bucknell University, whom the Illinois consortium called in to lead the project.

Throughout the interviews, students mentioned Google 115 times -- more than twice as many times as any other database. The prevalence of Google in student research is well-documented, but the Illinois researchers found something they did not expect: students were not very good at using Google. They were basically clueless about the logic underlying how the search engine organizes and displays its results. Consequently, the students did not know how to build a search that would return good sources. (For instance, limiting a search to news articles, or querying specific databases such as Google Book Search or Google Scholar.)

Duke and Asher said they were surprised by "the extent to which students appeared to lack even some of the most basic information literacy skills that we assumed they would have mastered in high school." Even students who were high achievers in high school suffered from these deficiencies, Asher told *Inside Higher Ed* in an interview.

In other words: Today's college students might have grown up with the language of the information age, but they do not necessarily know the grammar.

"I think it really exploded this myth of the 'digital native,' " Asher said. "Just because you've grown up searching things in Google doesn't mean you know how to use Google as a good research tool."

Even when students turned to more scholarly resources, that did not necessarily solve the problem. Many seemed confused about where in the constellation of library databases they should turn to locate sources for their particular research topic: Half wound up using databases a librarian "would most likely never recommend for their topic." For example, "Students regularly used JSTOR to try to find current research on a topic, not realizing that JSTOR does not provide access to the most recently published articles," Duke and Asher wrote in their paper, noting that "articles typically appear in JSTOR after 3-5 years, depending on their publisher." (JSTOR was the second-most frequently alluded-to database in student interviews, with 55 mentions.)

Years of conditioning on Google had not endowed the Illinois Wesleyan students with any searching savvy to speak of, but rather had instilled them with a stunted understanding of how to finely tune a search in order to home in on usable sources, concluded the ERIAL researchers.

Regardless of the advanced-search capabilities of the database they were querying, "Students generally treated all search boxes as the equivalent of a Google search box, and searched 'Google-style,' using the 'any word anywhere' keyword as a default," they wrote. Out of the 30 students Duke and Asher observed doing research, 27 failed to narrow their search criteria at all when doing so would have turned up more helpful returns.

Unsurprisingly, students using this method got either too many search results or too few. Frequently, students would be so discouraged they would change their research topic to something more amenable to a simple search.

"Many students described experiences of anxiety and confusion when looking for resources -- an observation that seems to be widespread among students at the five institutions involved in this study," Duke and Asher wrote.

These results can be taken in a positive light: as the library building has receded as a campus mecca, librarians have often had to combat the notion that online tools are making them irrelevant. The evidence from ERIAL lends weight to their counterargument: librarians are more relevant than they have ever been, since students need guides to shepherd them through the wilderness of the Web. Indeed, students who had attended library orientations or tutorials showed more proficiency than those who had not.

There was just one problem, Duke and Asher noted: "Students showed an almost complete lack of interest in seeking assistance from librarians during the search process." Of all the students they observed -- many of whom struggled to find good sources, to the point of despair -- not one asked a librarian for help.

In a separate study of students at DePaul, Illinois-Chicago, and Northeastern Illinois, other ERIAL researchers deduced several possible reasons for this. The most basic was that students were just as unaware of the extent of their own information illiteracy as everyone else. "Some students did not identify that they were having difficulties with which they could use help," wrote anthropologist Susan Miller and Nancy Murillo, a library instruction coordinator at Northeastern Illinois. "Some overestimated their ability or knowledge."

Another possible reason was that students seek help from sources they know and trust, and they do not know librarians. Many do not even know what the librarians are there for. "I don't think I would see them and say, 'Well, this is my research, how can I do this and that?' " one senior psychology major told the researchers. "I don't see them that way. I see them more like, 'Where's the bathroom?' " Other students imagined librarians to have more research-oriented knowledge of the library but still thought of them as glorified ushers.

"Librarians are believed to do work unrelated to helping students," wrote Miller and Murillo, "or work that, while possibly related to research, does not entitle students to relationships with them."

Co-opting the influence of professors

In lieu of librarians, whose relationship to any given student is typically ill-defined, students seeking help often turn to a more logical source: the person who gave them the assignment -- and who, ultimately, will be grading their work. "[R]elationships with professors … determine students' relationships with libraries," wrote Miller and Murillo. "In the absence of an established structure ensuring that students build relationships with librarians throughout their college careers, professors play a critical role in brokering students' relationships with librarians," they wrote.

Because librarians hold little sway with students, they can do only so much to rehabilitate students' habits. They need professors' help.

Unfortunately, professors are not necessarily any more knowledgeable about library resources than their students are. "Faculty may have low expectations for librarians, and consequently students may not be connected to librarians or see why working with librarians may be helpful," wrote Miller and Murillo.

Several recent studies by the nonprofit Ithaka S+R have highlighted the disjunct between how professors view the library and how the library views itself: library directors see the library as serving primarily a teaching function; professors see it above all as a purchasing agent. Miller and Murillo heard echoes of that in their study. "I think that what happens is the librarians know how to search for sources, but sometimes don't know how to do research," one anthropology professor told them.

Professors are usually willing to try to put students on the right path. However, "a student will not necessarily succeed in research if he or she relies on the professor alone," wrote Miller and Murillo. "… [Some] faculty members seemed to assume that students would pick up how to do library research, or that a one-shot instruction session, which at times professors erroneously assumed students previously had, would have been enough."

This finding resonated with the librarians gathered here in Chicago. "Students do enough to get by," says Lisa Wallis, a Web services librarian at Northeastern Illinois. "If they aren't told to use [specific library] databases, they won't." And many professors, like many librarians, overestimate the research fluency of their students. For example, a professor might tell students to find "scholarly sources" without considering that students do not actually know what a "scholarly source" is, says Logan, the Chicago reference librarian.

At DePaul, "One of the professors said, 'You mean they come to the library without the assignment?' " says Paula Dempsey, the coordinator of reference services there. "Yes. Yes, they do."

Heather Jagman, a coordinator of library instruction at DePaul, described this as the "curse of prior knowledge" -- a phenomenon to which both professors and librarians are vulnerable. Teaching and library faculty are likely to have been exceptionally skilled researchers as undergraduates. Career academics might have a hard time putting themselves in the shoes of a student who walks into the library knowing practically nothing.

Pragmatism vs. Idealism

Part of the challenge for faculty in learning to serve students more effectively might be adjusting their expectations to the realities of what students already know -- and can be reasonably expected to learn -- in the space of a given assignment, says Thill, the humanities librarian at Northeastern Illinois.

In her contribution to the ERIAL tome, called "Pragmatism and Idealism in the Academic Library," Thill wrote about the tension between library pragmatism -- the desire to satisfy the minimum requirements of a research assignment -- and library idealism, which glorifies the tedious unearthing and meticulous poring-over of texts. Unsurprisingly, most students tacked toward pragmatism, while "librarians and professors [repeatedly] wished that students could invest more time in contemplation and discovery, painting an idealized portrait of students leisurely wandering the stacks or pensively sitting down to await inspiration."

Her findings, based on open-ended interviews with 30 faculty members and nine librarians at Northeastern Illinois and DePaul, pointed to the tension between the idealized view of academic research and the practical matters of deadlines and other limitations -- a tension librarians often have to resolve. If a student needs sources on a topic but does not know how to retrieve them, does the librarian find the source for him? Does

she nudge him in the right direction but make sure he finds it himself? Librarians often have to walk that line between giving a person a fish and teaching her how to fish, proverbially speaking, says Thill. And the answer can rightly vary based on how quickly she needs a fish, whether she has the skills and coordination to competently wield a pole, and whether her ultimate goal is to become a master angler.

“Obviously I’m not saying we just have to be paper pushers -- just pushing out whatever it is the student wants,” Thill says. “But I think that, in general, we make decisions assuming that everyone is a career academic.”

This is treading on treacherous ground, and Thill knows it. The debate over whether librarians should be complicit in students’ efforts to “satisfice” -- that is, do what they can to get by and graduate -- can be a contentious one, since it runs to the root of what the library (and higher education in general) is for.

“To be honest I was almost afraid to write this paper,” she says, sitting in a conference room at the Northeastern Illinois library. “Whenever I talked to people about what my paper was about, they got their backs up.”

Thill says she does not think “satisfice” should be a dirty word. In her paper, she points to a 2008 NASPA Foundation study that indicated only 6 percent of college students earn a degree because they “like to learn for learning’s sake.” Back at the University of Illinois at Chicago, Logan mentioned the fact that a growing proportion of students are adult learners and first-generation students with jobs and family obligations. If these students are trying to “satisfice,” it probably isn't so that they'll have more time to goof off, she said.

There is also the somewhat dissonant fact that despite what the Illinois institutions now know about their students’ poor information literacy skills, many of those students have continued to pass their courses and eventually graduate. “I think we definitely saw that students are managing to get through without the level of certain research skills that we would like to see,” Asher told *Inside Higher Ed.*

“It’s not about teaching shortcuts, it’s about teaching them not to take the long way to a goal,” says Elisa Addlesperger, a reference and instruction librarian at DePaul. “They’re taking very long, circuitous routes to their goals.… I think it embitters them and makes them hate learning.” Teaching efficiency is not a compromise of librarianship, adds Jagman; it is a value.

Librarians and teaching faculty certainly have an obligation to encourage good, thorough research, says Thill, but they also have a responsibility to serve students -- and that means understanding the limitations of library idealism in practice, and acting pragmatically when necessary.

— Steve Kolowich

http://www.insidehighered.com/news/2011/08/22/erial_study_of_student_research_habits_at_illinois_university_libraries_reveals_alarmingly_poor_information_literacy_and_skills

IBM Builds Biggest Data Drive Ever

The system could enable detailed simulations of real-world phenomena—or store 24 billion MP3s.

- Thursday, August 25, 2011
- By Tom Simonite

A data repository almost 10 times bigger than any made before is being built by researchers at IBM's Almaden, California, research lab. The 120 petabyte "drive"—that's 120 million gigabytes—is made up of 200,000 conventional hard disk drives working together. The giant data container is expected to store around one trillion files and should provide the space needed to allow more powerful simulations of complex systems, like those used to model weather and climate.

A 120 petabyte drive could hold 24 billion typical five-megabyte MP3 files or comfortably swallow 60 copies of the biggest backup of the Web, the 150 billion pages that make up the Internet Archive's WayBack Machine.

The data storage group at IBM Almaden is developing the record-breaking storage system for an unnamed client that needs a new supercomputer for detailed simulations of real-world phenomena. However, the new technologies developed to build such a large repository could enable similar systems for more conventional commercial computing, says Bruce Hillsberg, director of storage research at IBM and leader of the project.

"This 120 petabyte system is on the lunatic fringe now, but in a few years it may be that all cloud computing systems are like it," Hillsberg says. Just keeping track of the names, types, and other attributes of the files stored in the system will consume around two petabytes of its capacity.

Steve Conway, a vice president of research with the analyst firm IDC who specializes in high-performance computing (HPC), says IBM's repository is significantly bigger than previous storage systems. "A 120-petabye storage array would easily be the largest I've encountered," he says. The largest arrays available today are about 15 petabytes in size. Supercomputing problems that could benefit from more data storage include weather forecasts, seismic processing in the petroleum industry, and molecular studies of genomes or proteins, says Conway.

IBM's engineers developed a series of new hardware and software techniques to enable such a large hike in data-storage capacity. Finding a way to efficiently combine the thousands of hard drives that the system is built from was one challenge. As in most data centers, the drives sit in horizontal drawers stacked inside tall racks. Yet IBM's researchers had to make those significantly wider than usual to fit more disks into a smaller area. The disks must be cooled with circulating water rather than standard fans.

The inevitable failures that occur regularly in such a large collection of disks present another major challenge, says Hillsberg. IBM uses the standard tactic of storing multiple copies of data on different disks, but it employs new refinements that allow a supercomputer to keep working at almost full speed even when a drive breaks down.

When a lone disk dies, the system pulls data from other drives and writes it to the disk's replacement slowly, so the supercomputer can continue working. If more failures occur among nearby drives, the rebuilding process speeds up to avoid the possibility that yet another failure occurs and wipes out some data

permanently. Hillsberg says that the result is a system that should not lose any data for a million years without making any compromises on performance.

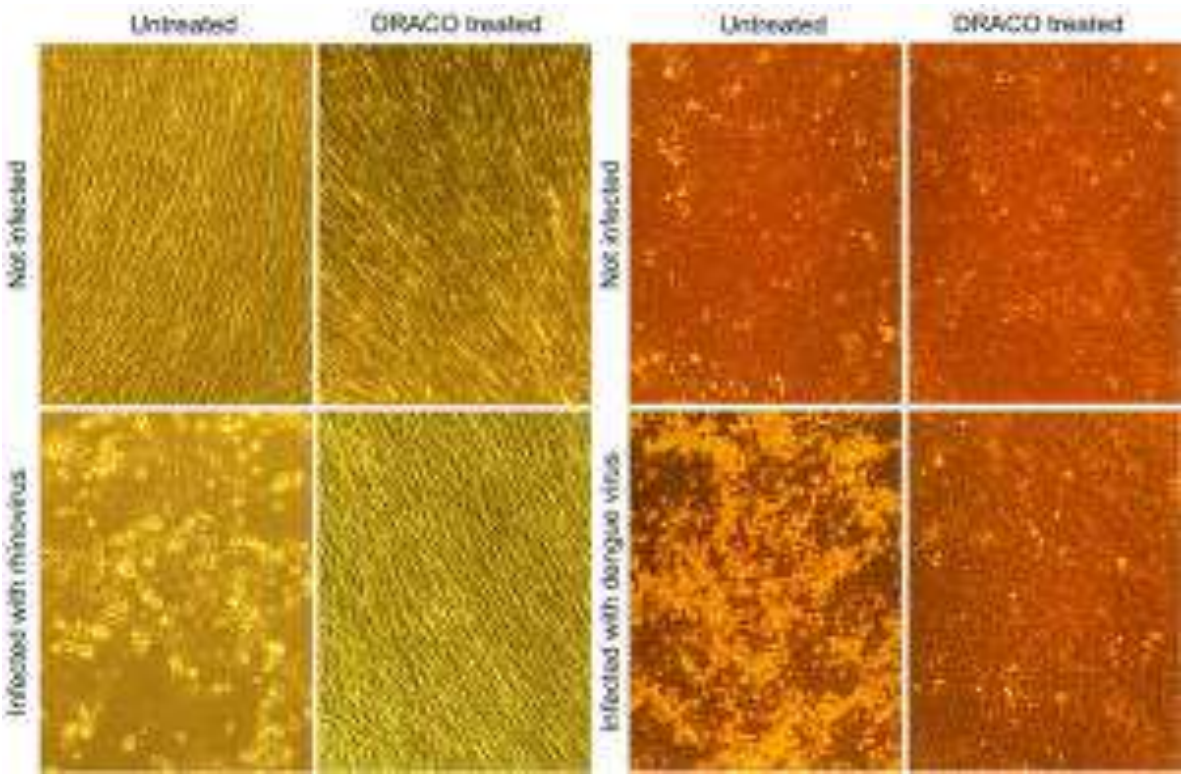
The new system also benefits from a file system known as GPFS that was developed at IBM Almaden to enable supercomputers faster data access. It spreads individual files across multiple disks so that many parts of a file can be read or written at the same time. GPFS also enables a large system to keep track of its many files without laboriously scanning through every one. Last month a team from IBM used GPFS to index 10 billion files in 43 minutes, effortlessly breaking the previous record of one billion files scanned in three hours.

Software improvements like those being developed for GPFS and disk recovery are crucial to enabling such giant data drives, says Hillsberg, because in order to be practical, they must become not only bigger, but also faster. Hard disks are not becoming faster or more reliable in proportion to the demands for more storage, so software must make up the difference.

IDC's Conway agrees that faster access to larger data storage systems is becoming crucial to supercomputing—even though supercomputers are most often publicly compared on their processor speeds, as is the case with the global TOP500 list used to determine international bragging rights. Big drives are becoming important because simulations are getting larger and many problems are tackled using so-called iterative methods, where a simulation is run thousands of times and the results compared, says Conway. "Checkpointing," a technique in which a supercomputer saves snapshots of its work in case the job doesn't complete successfully, is also common. "These trends have produced a data explosion in the HPC community," says Conway.

http://www.technologyreview.com/computing/38440/?ref=rss

Could New Drug Cure Nearly Any Viral Infection? Technology Shows Promise Against Common Cold, Influenza and Other Ailments, Researchers Say



The microscope images above show that DRACO successfully treats viral infections. In the left set of four photos, rhinovirus (the common cold virus) kills untreated human cells (lower left), whereas DRACO has no toxicity in uninfected cells (upper right) and cures an infected cell population (lower right). Similarly, in the right set of four photos, dengue hemorrhagic fever virus kills untreated monkey cells (lower left), whereas DRACO has no toxicity in uninfected cells (upper right) and cures an infected cell population (lower right). (Credit: Image courtesy of Massachusetts Institute of Technology)

ScienceDaily (Aug. 26, 2011) — Most bacterial infections can be treated with antibiotics such as penicillin, discovered decades ago. However, such drugs are useless against viral infections, including influenza, the common cold, and deadly hemorrhagic fevers such as Ebola.

Now, in a development that could transform how viral infections are treated, a team of researchers at MIT's Lincoln Laboratory has designed a drug that can identify cells that have been infected by any type of virus, then kill those cells to terminate the infection.

In a paper published July 27 in the journal *PLoS ONE*, the researchers tested their drug against 15 viruses, and found it was effective against all of them -- including rhinoviruses that cause the common cold, H1N1 influenza, a stomach virus, a polio virus, dengue fever and several other types of hemorrhagic fever.

The drug works by targeting a type of RNA produced only in cells that have been infected by viruses. "In theory, it should work against all viruses," says Todd Rider, a senior staff scientist in Lincoln Laboratory's Chemical, Biological, and Nanoscale Technologies Group who invented the new technology.

Because the technology is so broad-spectrum, it could potentially also be used to combat outbreaks of new viruses, such as the 2003 SARS (severe acute respiratory syndrome) outbreak, Rider says.

Other members of the research team are Lincoln Lab staff members Scott Wick, Christina Zook, Tara Boettcher, Jennifer Pancoast and Benjamin Zusman.

Few antivirals available

Rider had the idea to try developing a broad-spectrum antiviral therapy about 11 years ago, after inventing CANARY (Cellular Analysis and Notification of Antigen Risks and Yields), a biosensor that can rapidly identify pathogens. "If you detect a pathogenic bacterium in the environment, there is probably an antibiotic that could be used to treat someone exposed to that, but I realized there are very few treatments out there for viruses," he says.

There are a handful of drugs that combat specific viruses, such as the protease inhibitors used to control HIV infection, but these are relatively few in number and susceptible to viral resistance.

Rider drew inspiration for his therapeutic agents, dubbed DRACOs (Double-stranded RNA Activated Caspase Oligomerizers), from living cells' own defense systems.

When viruses infect a cell, they take over its cellular machinery for their own purpose -- that is, creating more copies of the virus. During this process, the viruses create long strings of double-stranded RNA (dsRNA), which is not found in human or other animal cells.

As part of their natural defenses against viral infection, human cells have proteins that latch onto dsRNA, setting off a cascade of reactions that prevents the virus from replicating itself. However, many viruses can outsmart that system by blocking one of the steps further down the cascade.

Rider had the idea to combine a dsRNA-binding protein with another protein that induces cells to undergo apoptosis (programmed cell suicide) -- launched, for example, when a cell determines it is en route to becoming cancerous. Therefore, when one end of the DRACO binds to dsRNA, it signals the other end of the DRACO to initiate cell suicide.

Combining those two elements is a "great idea" and a very novel approach, says Karla Kirkegaard, professor of microbiology and immunology at Stanford University. "Viruses are pretty good at developing resistance to things we try against them, but in this case, it's hard to think of a simple pathway to drug resistance," she says.

Each DRACO also includes a "delivery tag," taken from naturally occurring proteins, that allows it to cross cell membranes and enter any human or animal cell. However, if no dsRNA is present, DRACO leaves the cell unharmed.

Most of the tests reported in this study were done in human and animal cells cultured in the lab, but the researchers also tested DRACO in mice infected with the H1N1 influenza virus. When mice were treated with DRACO, they were completely cured of the infection. The tests also showed that DRACO itself is not toxic to mice.

The researchers are now testing DRACO against more viruses in mice and beginning to get promising results. Rider says he hopes to license the technology for trials in larger animals and for eventual human clinical trials.

This work is funded by a grant from the National Institute of Allergy and Infectious Diseases and the New England Regional Center of Excellence for Biodefense and Emerging Infectious Diseases, with previous funding from the Defense Advanced Research Projects Agency, Defense Threat Reduction Agency, and Director of Defense Research & Engineering (now the Assistant Secretary of Defense for Research and Engineering).

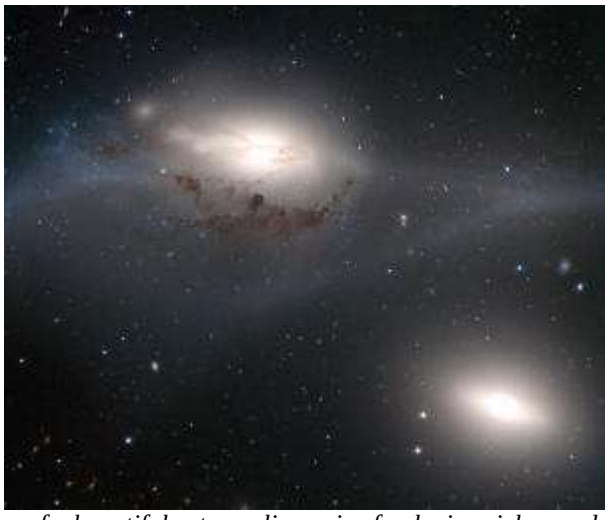
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by Massachusetts Institute of Technology. The original article was written by Anne Trafton, MIT News Office.

Journal Reference:

1. Todd H. Rider, Christina E. Zook, Tara L. Boettcher, Scott T. Wick, Jennifer S. Pancoast, Benjamin D. Zusman. Broad-Spectrum Antiviral Therapeutics. *PLoS ONE*, 2011; 6 (7): e22572 DOI: 10.1371/journal.pone.0022572

http://www.sciencedaily.com/releases/2011/08/110826134012.htm

Peculiar Pair of Galaxies Nicknamed 'The Eyes'



ESO's Very Large Telescope has taken a striking image of a beautiful yet peculiar pair of galaxies nicknamed The Eyes. The larger of these, NGC 4438, was once a spiral galaxy but has become badly deformed by collisions with other galaxies in the last few hundred million years. (Credit: Image courtesy of ESO)

ScienceDaily (Aug. 24, 2011) — The European Southern Observatory's Very Large Telescope has taken a striking image of a beautiful yet peculiar pair of galaxies nicknamed The Eyes. The larger of these, NGC 4438, was once a spiral galaxy but has become badly deformed by collisions with other galaxies in the last few hundred million years. This picture is the first to come out of ESO's Cosmic Gems programme, an initiative in which ESO has granted dedicated observing time for outreach purposes.

The Eyes are about 50 million light-years away in the constellation of Virgo (The Virgin) and are some 100 000 light-years apart. The nickname comes from the apparent similarity between the cores of this pair of galaxies -- two white ovals that resemble a pair of eyes glowing in the dark when seen in a moderate-sized telescope.

But although the centres of these two galaxies look similar, their outskirts could not be more different. The galaxy in the lower right, known as NGC 4435, is compact and seems to be almost devoid of gas and dust. In contrast, in the large galaxy in the upper left (NGC 4438) a lane of obscuring dust is visible just below its nucleus, young stars can be seen left of its centre, and gas extends at least up to the edges of the image.

The contents of NGC 4438 have been stripped out by a violent process: a collision with another galaxy. This clash has distorted the galaxy's spiral shape, much as could happen to the Milky Way when it collides with its neighbouring galaxy Andromeda in three or four billion years.

NGC 4435 could be the culprit. Some astronomers believe that the damage caused to NGC 4438 resulted from an approach between the two galaxies to within about 16 000 light-years that happened some 100 million years ago. But while the larger galaxy was damaged, the smaller one was significantly more affected by the collision. Gravitational tides from this clash are probably responsible for ripping away the contents of NGC 4438, and for reducing NGC 4435's mass and removing most of its gas and dust.

Another possibility is that the giant elliptical galaxy Messier 86, further away from The Eyes and not visible in this image, was responsible for the damage caused to NGC 4438. Recent observations have found filaments of ionised hydrogen gas connecting the two large galaxies, indicating that they may have collided in the past.

The elliptical galaxy Messier 86 and The Eyes belong to the Virgo Cluster, a very rich grouping of galaxies. In such close quarters, galaxy collisions are fairly frequent, so perhaps NGC 4438 suffered from encounters with both NGC 4435 and Messier 86.

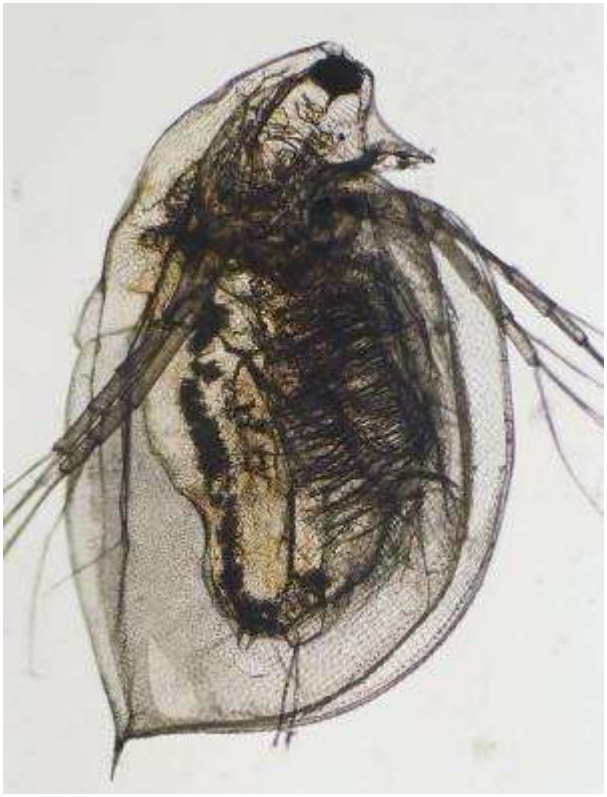
This picture is the first to be produced as part of the ESO Cosmic Gems programme. This is a new initiative to produce astronomical images for educational and public outreach purposes. The programme mainly makes use of time when the sky conditions are not suitable for science observations to take pictures of interesting, intriguing or visually attractive objects. The data are also made available to professional astronomers through ESO's science archive.

In this case, although there were some clouds, the atmosphere was exceptionally stable, which allowed very sharp details to be revealed in this image taken using the VLT's FORS2 instrument. Light passing through two different filters was used: red (coloured red) and green-yellow (coloured blue), and the exposure times were 1800 seconds and 1980 seconds, respectively. FORS2 is the visual and near ultraviolet FOcal Reducer and low dispersion Spectrograph for the VLT. It is installed on the VLT's Unit Telescope 1.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by European Southern Observatory - ESO.

http://www.sciencedaily.com/releases/2011/08/110824091512.htm

Possible Biological Control Discovered for Pathogen Devastating Amphibians



Researchers have confirmed that this zooplankton, Daphni magna, will eat a deadly fungus that is devastating amphibian populations around the world. It may provide a new biocontrol agent to help address this crisis. (Credit: Photo courtesy of Oregon State University)

ScienceDaily (Aug. 25, 2011) — Zoologists at Oregon State University have discovered that a freshwater species of zooplankton will eat a fungal pathogen which is devastating amphibian populations around the world.

This tiny zooplankton, called *Daphnia magna*, could provide a desperately needed tool for biological control of this deadly fungus, the scientists said, if field studies confirm its efficacy in a natural setting.

The fungus, *B. dendrobatidis*, is referred to as a "chytrid" fungus, and when it reaches high levels can disrupt electrolyte balance and lead to death from cardiac arrest in its amphibian hosts. One researcher has called its impact on amphibians "the most spectacular loss of vertebrate biodiversity due to disease in recorded history."

The research, reported August 26 in the journal *Biodiversity and Conservation*, was supported by the National Science Foundation.

"There was evidence that zooplankton would eat some other types of fungi, so we wanted to find out if Daphnia would consume the chytrid fungus," said Julia Buck, an OSU doctoral student in zoology and lead author on the study. "Our laboratory experiments and DNA analysis confirmed that it would eat the zoospore, the free-swimming stage of the fungus."

"We feel that biological control offers the best chance to control this fungal disease, and now we have a good candidate for that," she said. "Efforts to eradicate this disease have been unsuccessful, but so far no one has attempted biocontrol of the chytrid fungus. That may be the way to go."

The chytrid fungus, which was only identified in 1998, is not always deadly at low levels of infestation, Buck said. It may not be necessary to completely eliminate it, but rather just reduce its density in order to prevent mortality. Biological controls can work well in that type of situation.

Amphibians have been one of the great survival stories in Earth's history, evolving about 400 million years ago and surviving to the present while many other life forms came and went, including the dinosaurs. But in recent decades the global decline of amphibians has reached crisis proportions, almost certainly from multiple causes that include habitat destruction, pollution, increases in ultraviolet light due to ozone depletion, invasive species and other issues.

High on the list, however, is the chytrid fungus that has been documented to be destroying amphibians around the world, through a disease called chytridiomycosis.

Its impact has been severe and defied various attempts to control it, even including use of fungicides on individual amphibians. Chytridiomycosis has been responsible for "unprecedented population declines and extinctions globally," the researchers said in their report.

"About one third of the amphibians in the world are now threatened and many have gone extinct," said Andrew Blaustein, a professor of zoology, co-author on this study and an international leader in the study of amphibian decline.

"It's clear there are multiple threats to amphibians, but disease seems to be a dominant cause," he said.

Although they have survived for hundreds of millions of years, amphibians may be especially vulnerable to rapid environmental changes and new challenges that are both natural and human-caused. They have a permeable skin, and exposure to both terrestrial and aquatic environments.

Because of this, OSU researchers said, other animals such as mammals, birds and fish have so far not experienced such dramatic population declines.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by Oregon State University.

Journal Reference:

1. Julia C. Buck, Lisa Truong, Andrew R. Blaustein. Predation by zooplankton on Batrachochytrium dendrobatidis: biological control of the deadly amphibian chytrid fungus? *Biodiversity and Conservation*, 2011; DOI: 10.1007/s10531-011-0147-4

http://www.sciencedaily.com/releases/2011/08/110826111303.htm

First Glimpse Into Birth of the Milky Way

On the left, is an image of our simulated galaxy, with gas in red and stars in blue; on the right, a picture in false colors of the galaxy M74, again with gas shown in red and stars in blue. The spiral arms of the gas are evident in both images. (Credit: Image courtesy of University of Zurich)

ScienceDaily (Aug. 27, 2011) — For almost 20 years astrophysicists have been trying to recreate the formation of spiral galaxies such as our Milky Way realistically. Now astrophysicists from the University of Zurich present the world's first realistic simulation of the formation of our home galaxy together with astronomers from the University of California at Santa Cruz. The new results were partly calculated on the computer of the Swiss National Supercomputing Center (CSCS) and show, for instance, that there has to be stars on the outer edge of the Milky Way.

The aim of astrophysical simulations is to model reality in due consideration of the physical laws and processes. Astronomical sky observations and astrophysical simulations have to match up exactly. Being able to simulate a complex system like the formation of the Milky Way realistically is the ultimate proof that the underlying theories of astrophysics are correct. All previous attempts to recreate the formation of spiral galaxies like the Milky Way faltered on one of two points: Either the simulated spiral galaxies displayed too many stars at the center or the overall stellar mass was several times too big.

A research group jointly run by Lucio Mayer, an astrophysicist at the University of Zurich, and Piero Madau, an astronomer at University of California at Santa Cruz, is now publishing the first realistic simulation of the formation of the Milky Way in the *Astrophysical Journal*. Javiera Guedes and Simone Callegari, who are PhD students at Santa Cruz and the University of Zurich respectively, performed the simulation and analyzed the data. Guedes will be working on the formation of galaxies as a postdoc in Zurich from the fall.

Removing standard matter central to formation of spiral galaxies

For their study, the scientists developed a highly complex simulation in which a spiral galaxy similar to the Milky Way develops by itself without further intervention. Named after Eris, the Greek goddess of strife and discord, because of the decades of debate surrounding the formation of spiral galaxies, the simulation offers a glimpse in time lapse into almost the entire genesis of a spiral galaxy. Its origins date back to less than a

million years after the Big Bang. "Our result shows that a realistic spiral galaxy can be formed based on the basic principles of the cold dark matter paradigm and the physical laws of gravity, fluid dynamics and radiophysics," explains Mayer.

The simulation also shows that in an entity that is supposed to develop into a spiral galaxy, the stars in the areas with giant cloud gas complexes have to form. In these cold molecular giant clouds, the gases exhibit extremely high densities. The star formation and distribution there does not occur uniformly, but rather in clumps and clusters. This in turn results in a considerably greater build-up of heat through local supernova explosions. Through this massive build-up of heat, visible standard matter is removed at high redshift. This prevents the formation of a concave disk in the center of the galaxy. The removal of baryonic matter, as the visible standard matter is also known, also reduces the overall mass of the gas present at the center. This results in the formation of the correct stellar mass, as can be observed in the Milky Way. At the end of the simulation, a thin, curved disk results that corresponds fully to the astronomical observations of the Milky Way in terms of the mass, angular momentum and rotation velocity ratios.

Astronomical computing power

For the calculations, the model Mayer and co. developed for the simulation of disk-shaped dwarf galaxies and published in the journal *Nature* in 2010 was refined. The high-resolution model simulates the formation of a galaxy with 790 billion solar masses and comprises 18.6 million particles, from which gases, dark matter and stars form. The high resolution of the numerical simulations is essential for the groundbreaking new results. For the calculations, the high-performance supercomputers Cray XT5 "Monte Rosa" at ETH Zurich's Swiss National Supercomputing Center (CSCS) and the NASA Advanced Supercomputer Division's Pleiades were used. A regular PC would have needed 570 years for the calculations.

Stars and gases at the outermost edge of the galaxy, hot gases at its center

The new simulation confirms the results for the formation of disk-shaped dwarf galaxies published by Mayer and demonstrates that the model -- unlike all previous approaches -- can recreate both small and extremely large galaxies realistically. Moreover, from the simulation it an also be deduced that protogalaxies with a large disk made of gases and stars at the center already formed a billion years after the Big Bang, and therefore long before our present galaxies.

Based on the simulation, the ratio of "cold dark matter" (CDM) and standard matter in spiral galaxies can also be adjusted. In order to obtain the correct overall stellar mass in the final stage of the galaxy -- until now, one of the main difficulties -- it is imperative that standard matter be removed from the center by supernova winds. On the strength of the simulation, it is highly probable that the ratio of standard matter to CDM on the outermost edge of the CDM rings of a spiral galaxy is 1:9, not 1:6 as previously assumed.

The simulation also predicts stars and gases for the outer halo of the Milky Way six hundred thousand light years away. Only the next generation of space probes and telescopes will be able to detect these extremely faint stars. Furthermore, the simulation makes predictions with regard to the radial distribution of hot gases around the galaxy's central disk. Future telescopes that can measure X-rays, as the IXO Mission of the European Space Agency (ESA) is planning, for example, will test these predictions.

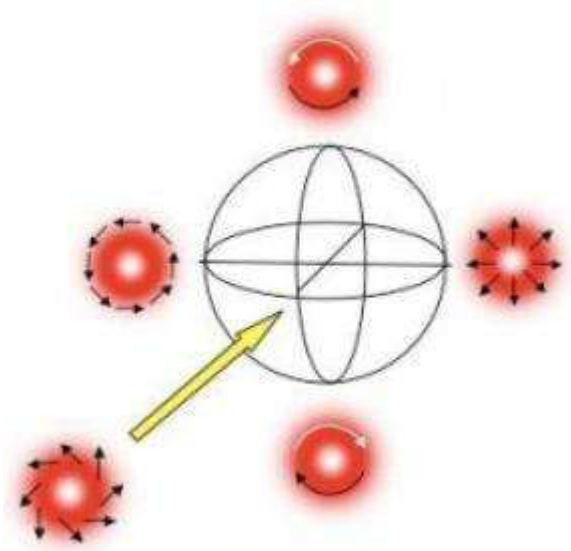
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by University of Zurich.

Journal Reference:

1. Javiera Guedes, Simone Callegari, Piero Madau, Lucio Mayer. Forming Realistic Late-Type Spirals in A CDM Universe: The Eris Simulation. *The Astrophysical Journal*, 2011 (accepted) [link]

http://www.sciencedaily.com/releases/2011/08/110825090227.htm

New Depiction of Light Could Boost Telecommunications Channels



Higher Order Poincare Sphere model developed by physicists with the Institute of Ultrafast Spectroscopy and Lasers tracks movement of complex forms of light. (Credit: Image courtesy of City College of New York)

ScienceDaily (Aug. 26, 2011) — Physicists with the Institute of Ultrafast Spectroscopy and Lasers (IUSL) at The City College of New York have presented a new way to map spiraling light that could help harness untapped data channels in optical fibers. Increased bandwidth would ease the burden on fiber-optic telecommunications networks taxed by an ever-growing demand for audio, video and digital media. The new model, developed by graduate student Giovanni Milione, Professor Robert Alfano and colleagues, could even spur enhancements in quantum computing and other applications.

"People now can detect (light in) the ground channel, but this gives us a way to detect and measure a higher number of channels," says Mr. Milione. With such heavy traffic funneled through a single channel, there is great interest in exploiting others that can be occupied by complex forms of light, he explains.

The team published their work in the July 25 issue of *Physical Review Letters*. Mr. Milione will present it at the Optical Society of America's "Frontiers in Optics 2011" conference, October 16-20 in San Jose, Calif.

Polarization is everything to a physicist tracking light in an optical fiber or laser. More than a way to cut glare with sunglasses, polarization refers to a specific direction and orientation of the light's movement and electric field -- when it isn't going every which way as it does when emanating from a light bulb, for example.

"Being able to follow polarization and other changes as light travels gives you insight into the material it travels through, " explains Milione. This helps control the light and can essentially give a fingerprint of the material being analyzed.

Detecting the polarization also lets users finely tune a laser. Such control can allow a laser to burn away one layer of material while leaving the other layers it passes through intact.

Until now, only the simplest form of light, the ground state, could be mapped and controlled. Multiple higher channels in an optical fiber, which could be occupied by more complex light, were left sitting idle.

A globe-shaped model, called the Poincaré Sphere, has long been used to map such simple light. This light has peaks and troughs, like waves on the ocean, and moves or vibrates in "plane waves." One maps how light intersects the sphere in the same way one pinpoints a location on Earth using longitude and latitude.

But complex light moves with both spin and orbital angular momentum, more or less like the movement of our moon as it spins on its axis and orbits Earth.

Such light twists like a tornado as it travels through space and takes the form of what are called vector beams and vortices. To map these vortices the researchers expanded the existing sphere to develop their Higher Order Poincaré Sphere (HOPS).

The team studies even more complex patterns of light, such as star-shaped forms. Their model uses the HOPS to reduce what could be pages of mathematics to single equations. These are the mathematical tools that will harness the complex light for use in technology.

"The sphere facilitates understanding, showing phase vortices are on poles and vector beams are on the equator," explains Milione. "It organizes the relationship between these vortices of light."

"This kind of organization on the higher level Poincaré Sphere could clear the path to a number of novel physics and engineering efforts such as quantum computing and optical transitions; could greatly expand the sensitivity of spectroscopy and the complexity of computer cryptography; and might further push the boundaries what can be 'seen'," said Dr. Alfano.

The research was funded in part by Corning Inc. and the Army Research Office.

Story Source:

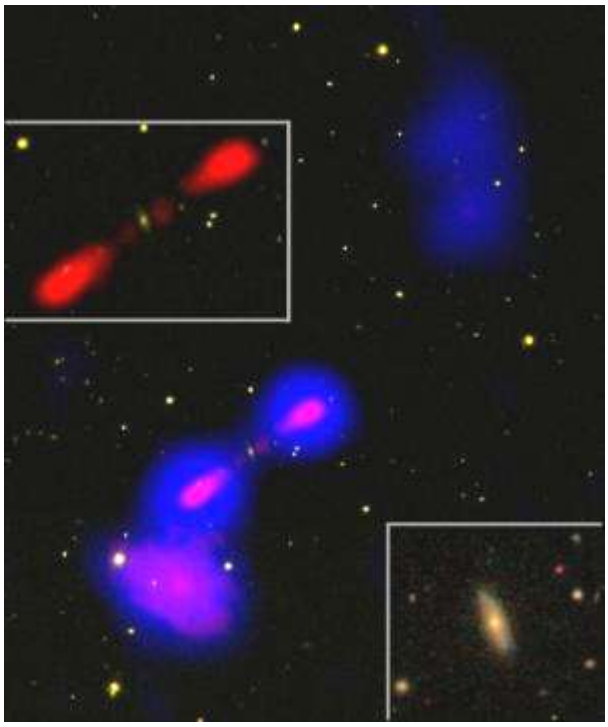
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by City College of New York.

Journal Reference:

1. Giovanni Milione, H. Sztul, D. Nolan, R. Alfano. Higher-Order Poincaré Sphere, Stokes Parameters, and the Angular Momentum of Light. *Physical Review Letters*, 2011; 107 (5) DOI: 10.1103/PhysRevLett.107.053601

http://www.sciencedaily.com/releases/2011/08/110825164929.htm

Exotic Galaxy Reveals Tantalizing Tale



Composite image of Speca: Optical SDSS image of the galaxies in yellow, low resolution radio image from NVSS in blue, high resolution radio image from GMRT in red. (Credit: Hota et al., SDSS, NCRA-TIFR, NRAO/AUI/NSF)

ScienceDaily (Aug. 26, 2011) — A galaxy with a combination of characteristics never seen before is giving astronomers a tantalising peek at processes they believe played key roles in the growth of galaxies and clusters of galaxies early in the history of the Universe.

The galaxy, dubbed Speca by the team of researchers, is only the second spiral, as opposed to elliptical, galaxy known to produce large, powerful jets of subatomic particles moving at nearly the speed of light. It also is one of only two galaxies to show that such activity occurred in three separate episodes. The scientists publish their results in the journal Monthly Notices of the Royal Astronomical Society.

Giant jets of superfast particles are powered by supermassive black holes at the cores of galaxies. Both elliptical and spiral galaxies harbour such black holes, but only Speca and one other spiral galaxy have been seen to produce large jets. The jets pour outward from the poles of rapidly-rotating disks of material orbiting the black hole. The on-and-off jet episodes have been seen in a dozen ellipticals, but only one other elliptical shows evidence, like Speca, for three such distinct episodes.

"This is probably the most exotic galaxy with a black hole ever seen. It has the potential to teach us new lessons about how galaxies and clusters of galaxies formed and developed into what we see today," said Ananda Hota, of the Academia Sinica Institute of Astronomy and Astrophysics (ASIAA), in Taiwan.

The scientists believe that Speca, about 1.7 billion light-years from Earth, and the 60-some other galaxies in a cluster with it are providing a look at what young galaxies and clusters may have been like when the Universe was much younger. In the young Universe, galaxies in such clusters would have been gathering up additional material, colliding with each other, undergoing bursts of star formation, and interacting with primordial material falling into the cluster from outside.

"Speca is showing evidence for many of these phenomena," Ananda said, adding that "We hope to find many more galaxies like it with future observations, and to learn more about the processes and an environment that were much more common when the Universe was a fraction of its current age."

Speca (an acronym for Spiral-host Episodic radio galaxy tracing Cluster Accretion) first came to Ananda's attention in an image that combined data from the visible-light Sloan Digital Sky Survey and the FIRST survey done with the National Science Foundation's Very Large Array (VLA) radio telescope. Follow-up observations with the Lulin optical telescope in Taiwan and ultraviolet data from NASA's GALEX satellite confirmed that the giant lobes of radio emission, usually seen coming from elliptical galaxies, were coming from a spiral galaxy with ongoing star formation.

Ananda's team also examined the galaxy in images from the NRAO VLA Sky Survey (NVSS), then made new observations with the Giant Meterwave Radio Telescope (GMRT) in India, which observes at longer wavelengths than the VLA and is the premier telescope for observing at those long wavelengths.

With this impressive variety of data from across the electromagnetic spectrum, the researchers unravelled the galaxy's complex and fascinating history.

The radio images from the VLA FIRST survey had shown one pair of radio-emitting lobes. The VLA's NVSS images showed another, distinct pair of lobes farther from the galaxy. The GMRT images confirmed this second pair, but showed another, smaller pair close to the galaxy, presumably produced by the most-recently ejected jet particles.

"By using these multiple sets of data, we found clear evidence for three distinct epochs of jet activity," Ananda explained.

The biggest surprise -- the low-frequency nature of the oldest, outermost lobes -- gave a valuable clue about the galaxy's -- and the cluster's -- environment. The outermost radio-emitting lobes are old enough that their particles should have lost most of their energy and ceased to produce radio emission.

"We think these old, relic lobes have been 're-lighted' by shock waves from rapidly-moving material falling into the cluster of galaxies as the cluster continues to accrete matter," said Ananda.

"All these phenomena combined in one galaxy make Speca and its neighbours a valuable laboratory for studying how galaxies and clusters evolved billions of years ago," Ananda said.

Sandeep K. Sirothia of India's National Centre for Radio Astrophysics, Tata Institute of Fundamental Research (NCRA-TIFR) said, "The ongoing low-frequency TIFR GMRT Sky Survey will find many more relic radio lobes of past black hole activity and energetic phenomena in clusters of galaxies like those we found in Speca."

Govind Swarup of NCRA-TIFR, who is not part of the team, described the finding as "an outstanding discovery that is very important for cluster formation models and highlights the importance of sensitive observations at meter wavelengths provided by the GMRT."In addition to Ananda and Sandeep, the research team includes: Youichi Ohyama, Chiranjib Konar, and Satoki Matsuchita of ASIAA; Suk Kim and Soo-Chang Rey of Chungnam National University in Korea; D.J. Saikia of NCRA and Judith H. Croston of the University of Southampton in England.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by Royal Astronomical Society (RAS).

Journal Reference:

1. Ananda Hota, S. K. Sirothia, Youichi Ohyama, C. Konar, Suk Kim, Soo-Chang Rey, D. J. Saikia, J. H. Croston, Satoki Matsushita. Discovery of a spiral-host episodic radio galaxy. *Monthly Notices of the Royal Astronomical Society: Letters*, 2011; DOI: 10.1111/j.1745-3933.2011.01115.x

http://www.sciencedaily.com/releases/2011/08/110825135156.htm

Earth-Bound Asteroids Come from Stony Asteroids, New Studies Confirm

This is a Hayabusa capsule landed at Woomera in South Australia. (Credit: Image copyright JAXA/ISIS)

ScienceDaily (Aug. 26, 2011) — Researchers got their first up-close look at dust from the surface of a small, stony asteroid after the Hayabusa spacecraft scooped some up and brought it back to Earth. Analysis of these dust particles, detailed in a special issue of the journal *Science* this week, confirms a long-standing suspicion: that the most common meteorites found here on Earth, known as ordinary chondrites, are born from these stony, or S-type, asteroids. And since chondrites are among the most primitive objects in the solar system, the discovery also means that these asteroids have been recording a long and rich history of early solar system events.

The 26 August issue of *Science* includes six reports and a Perspective article that highlight the initial studies of this asteroid dust.

The Hayabusa spacecraft was launched by the Japan Aerospace Exploration Agency (JAXA) in 2003 to sample the surface of the near-Earth asteroid known as 25143 Itokawa. The unmanned vessel reached its destination a little more than two years later -- and in November 2005, it made two separate touchdowns on the surface of Itokawa. Although its primary sampler malfunctioned, the spacecraft was able to strike the asteroid's surface with an elastic sampling horn and catch the small amount of dust particles that were kicked up. After reentering Earth's atmosphere and landing in South Australia in June 2010, Hayabusa's delicate samples were analyzed extensively by various teams of researchers.

"*Science* is very excited and pleased to be presenting these important scientific analyses," said Brooks Hanson, Deputy Editor of the Physical Sciences. "The first samples that researchers collected beyond Earth were from the moon, and the first analyses of those samples were also published in *Science*. Those samples, along with the more recent sampling of a comet and the solar wind, have changed our understanding of the solar system and Earth. They are still yielding important results. These Hayabusa samples are the first samples of an asteroid. Not only do they provide important information about the history of the asteroid Itokawa, but by providing the needed ground truth that is only possible through direct sampling, they also help make other important samples -- like meteorite collections and the lunar samples -- even more useful."

The asteroid sampled by Hayabusa is a rocky, S-type asteroid with the appearance of a rubble pile. Based on observations from the ground, researchers have believed that similar S-type asteroids, generally located in our solar system's inner and middle asteroid belt, are responsible for most of the small meteorites that regularly strike Earth. But, the visible spectra of these asteroids have never precisely matched those of ordinary chondrites -- a fact that has left researchers suspicious of their actual affiliation. The only way to confirm a direct relationship between meteorites and these S-type asteroids was to physically sample the regolith from an asteroid's surface.

Tomoki Nakamura from Tohoku University in Sendai, Japan and colleagues from across the country and in the United States were among the first to analyze this regolith brought back by Hayabusa. The team of researchers used a combination of powerful electron microscopes and X-ray diffraction techniques to study the mineral chemistry of Itokawa's dust particles.

"Our study demonstrates that the rocky particles recovered from the S-type asteroid are identical to ordinary chondrites, which proves that asteroids are indeed very primitive solar system bodies," said Nakamura.

The researchers also noticed that Itokawa's regolith has gone through significant heating and impact shocks. Based on its size, they conclude that the asteroid is actually made up of small fragments of a much bigger asteroid.

"The particles recovered from the asteroid have experienced long-term heating at about 800 degrees Celsius," said Nakamura. "But, to reach 800 degrees, an asteroid would need to be about 12.4 miles (20 kilometers) in diameter. The current size of Itokawa is much smaller than that so it must have first formed as a larger body, then been broken by an impact event and reassembled in its current form."

Separate teams of researchers, including Mitsuru Ebihara from Tokyo Metropolitan University and colleagues from the United States and Australia, cut open the tiny regolith grains returned by Hayabusa to get a look at the minerals inside them. Their composition shows that the dust grains have preserved a record of primitive elements from the early solar system. Now, those mineral compositions can be compared to tens of thousands of meteorites that have fallen to Earth, and then correlated to the visible spectra of other asteroids in space.

Akira Tsuchiyama from Osaka University in Toyonaka, Japan and colleagues from around the world also analyzed the three-dimensional structures of the dust particles. Since dust from the surface of the moon is the only other type of extraterrestrial regolith that researchers have been able to sample directly (from the Apollo and Luna missions), these researchers closely compared the two types.

"The cool thing about this Itokawa analysis is the tremendous amount of data we can get from such a small sample," said Michael Zolensky from the NASA Johnson Space Center in Houston, Texas, a co-author of the research. "When researchers analyzed regolith from the moon, they needed kilogram-sized samples. But, for the past 40 years, experts have been developing technologies to analyze extremely small samples. Now, we've gained all this information about Itokawa with only a few nano-grams of dust from the asteroid."

According to the researchers, Itokawa's regolith has been shaped by erosion and surface impacts on the asteroid, whereas lunar regolith, which has spent more time exposed to solar winds and space weathering, has been more chemically altered.

Takaaki Noguchi from Ibaraki University in Mito, Japan, and colleagues cite this chemical difference between the lunar dust and the Itokawa samples as one of the reasons astronomers have never been able to definitively tie ordinary chondrites to S-type asteroids in the past.

"Space weathering is the interaction between the surface of airless bodies, like asteroids and the moon, and the energetic particles in space," said Noguchi. "When these energetic particles -- like solar wind, plasma ejected from the Sun and fast-traveling micrometeoroids -- strike an object, pieces of them condense on the surface of that object. In the vacuum of space, such deposits can create small iron particles that greatly affect the visible spectra of these celestial bodies when they are viewed from Earth."

But now, instead of using lunar samples to estimate the space weathering on an asteroid in the future, researchers can turn to the asteroid regolith for direct insight into such processes.

Two more international studies led by Keisuke Nagao from the University of Tokyo and Hisayoshi Yurimoto from Hokkaido University in Sapporo, Japan, respectively, have determined how long the regolith material has been on the surface of Itokawa and established a direct link between the oxygen isotopes in ordinary chondrites and their parent, S-type asteroids.

According to the researchers, the dust from Itokawa has been on the surface of the asteroid for less than eight million years. They suggest that regolith material from such small asteroids might escape easily into space to become meteorites, traveling toward Earth.

"This dust from the surface of the Itokawa asteroid will become a sort of Rosetta Stone for astronomers to use," according to Zolensky. "Now that we understand the bulk mineral and chemical composition of the Hayabusa sample, we can compare them to meteorites that have struck the Earth and try to determine which asteroids the chondrites came from."

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The report by Noguchi *et al.* received additional support from the NASA Muses-CN/Hayabusa Program.

The report by Tsuchiyama *et al.* received additional support from a grant-in-aid of the Japan Ministry of Education, Culture, Sports, Science and Technology and the NASA Muses-CN/Hayabusa Program.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by American Association for the Advancement of Science, via EurekAlert!, a service of AAAS.

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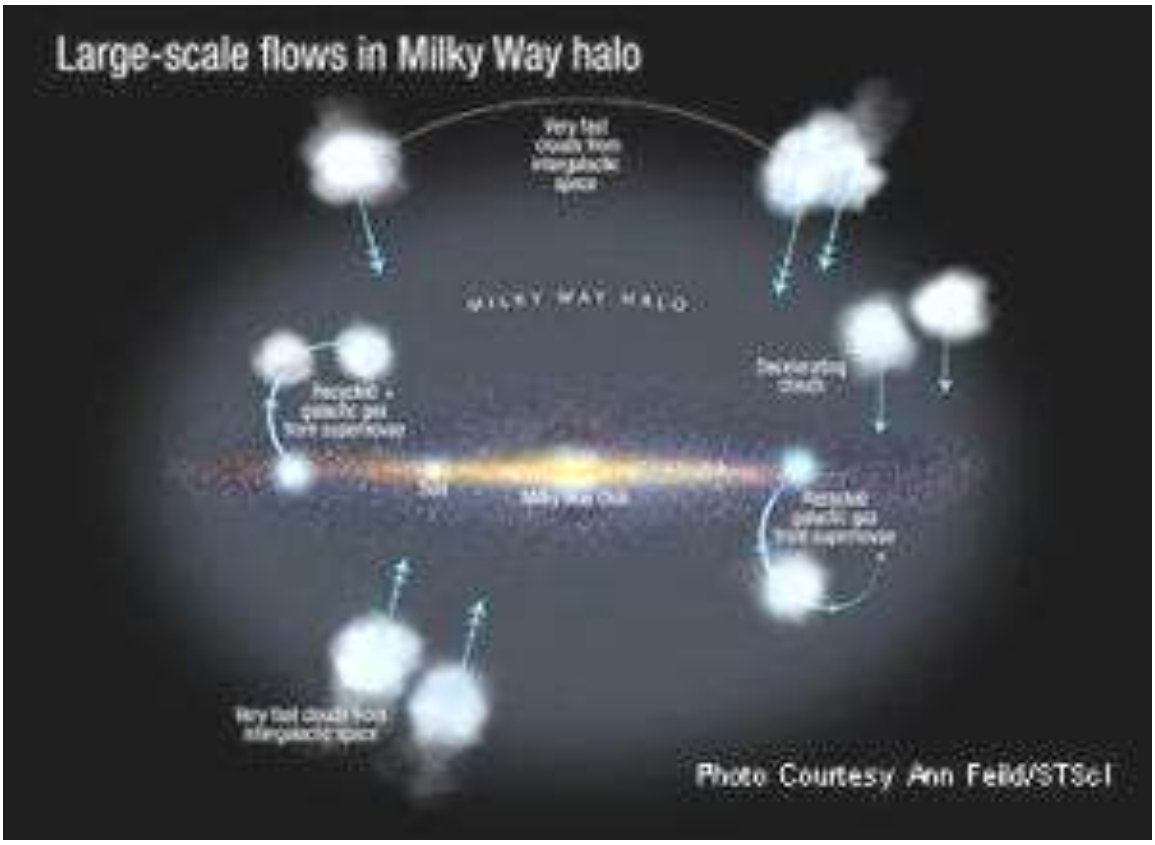
Milky Way's Halo Raining Ionized Gas to Fuel Continued Star Formation



Large scale flows in Milky Way halo. (Credit: Image courtesy of University of Notre Dame)

ScienceDaily (Aug. 26, 2011) — The Milky Way will have the fuel to continue forming stars, thanks to massive clouds of ionized gas raining down from its halo and intergalactic space. This is the conclusion of a new study by Nicolas Lehner and Christopher Howk, faculty in the Department of Physics at the University of Notre Dame.

Their report was published in *Science* on Aug. 26.

Using the Cosmic Origins Spectrograph, one of the newest instruments on the NASA/ESA Hubble Space Telescope, these researchers measured for the first time the distances to fast-moving clouds of ionized gas previously seen covering a large fraction of the sky. These fast-moving clouds reside in the distant reaches of the Milky Way and contain huge quantities of gas.

The Milky Way would rapidly change its gas into stars if no supply of new matter were available to replenish the gas. Astronomers have hypothesized that the ionized fast-moving gas clouds could be this reservoir of gas, but it was not known if they were interacting with the Milky Way.

"Our findings explain why the Milky Way can keep having star formation," Lehner says. "Knowing the distances to these clouds tells us where the gaseous fuel is for forming stars over billions of years."

Gas clouds can be identified and studied because elements in the cloud absorb small amounts of the light from a star or other light source as it passes through a cloud on its way to Earth. The characteristic "fingerprint" left in the spectrum allows astronomers to determine the properties of the gas.

Star Formation in the Milky Way

Earlier studies of these fast-moving ionized clouds used light from quasars, which are too far away to mark the clouds' locations. To solve the problem, Lehner and Howk identified 27 stars around the Milky Way, whose distances were known, and used the Hubble to take line-of-sight readings of light coming from them.

Results from the stellar sample showed the ionized clouds largely resided in the Milky Way's halo. The authors concluded that these flows of ionized gas are within about one Galactic radius (40,000 light years) of Earth. The new Hubble observations revealed the presence of ionized gas in half the stellar sample, comparable to the fraction observed toward more distant quasars.

The gas clouds are not uniformly distributed around the Galaxy, but rather collected in different areas. They cover only part of our Galactic sky, analogous to the partial coverage of the sky on a partly cloudy day on Earth. This research also confirmed models that predicted gas falling into the Milky Way slows as it approaches. Clouds closer to the Galaxy seem to have been decelerated and do not move as fast as those farther away, much like a meteorite slowing as it enters Earth's atmosphere.

"We know now where is the missing fuel for Galactic star formation." Lehner concludes. "We now have to learn how it got there."

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by University of Notre Dame.

Journal Reference:

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Simple Way to Grow Muscle Tissue With Real Muscle Structure

Researcher Dr. Daisy van der Schaft of Eindhoven University of Technology working on the preparation of muscle tissue cultures. (Credit: Eindhoven University of Technology/Bart van Overbeeke)

ScienceDaily (Aug. 26, 2011) — Researchers at Eindhoven University of Technology (TU/e) have found a simple way to grow muscle tissue with real muscle structure in the laboratory. They found that the muscle cells automatically align themselves if they are subjected to tension in one direction -- this is essential for the ability of the muscle cells to exert a force. The endothelial (blood vessel) cells in the culture also automatically grouped themselves to form new blood vessels. This finding is a step forward towards the engineering of thicker muscle tissue that can for example be implanted in restoration operations.

The results were published in the scientific journal *Tissue Engineering Part A.*

Another important aspect of the finding is that it was not necessary to add any biochemical growth factors to initiate the process. These substances are normally required for processes of this kind, but their action is difficult to control, according to TU/e researcher Dr. Daisy van der Schaft.

Disorganized

Other researchers have also succeeded in engineering muscle tissue containing blood vessels, but in these cases the muscle cells and blood vessels were disorganized. To give the muscles their strength, all the muscle cells need to be aligned in the same direction. Additionally, the muscles need blood vessels to supply them with oxygen and nutrients.

Tension

The TU/e research team produced engineered muscle tissue from a mixture of precultured stem cells and blood vessel cells (both from mice) in a gel. They then fastened the pieces of cultured tissue, measuring 2 x 8 mm, in one direction using pieces of Velcro. The stem cells then changed into muscle cells. This process normally involves shrinkage of the tissue. However, because the tissue was fastened this shrinkage was prevented, and the resulting tension caused the muscle cells to become aligned during the culturing process. This alignment is essential for the muscles to be able to exert a force.

Growth factors produced

In addition, the blood vessel cells organized themselves to form blood vessels, without the researchers needing to add any growth factors -- these were created automatically. Measurements by the researchers showed that the muscle cells produced the required growth factor themselves, as a result of the tension to which they were subjected.

Thicker tissue

The formation of blood vessels is an important step to allow the engineering of thicker muscle tissue. Up to now the maximum thickness that could be achieved was 0.4 mm, because the cells must be located no further than 0.2 mm from a blood vessel or other source of nutrients to ensure that they receive sufficient oxygen. The blood supply through the blood vessels means that in the near future it will be possible to feed the engineered muscle tissue from within, making it possible to culture thicker tissue.

Not just cosmetic

The aim of the research is ultimately to allow the treatment of people who have lost muscle tissue, for example through accidents or surgery to remove tumors. "Just one example is the restoration of facial tissue," explains Van der Schaft. Using these engineered muscle tissues would not just be cosmetic, but would give function back to the tissue." She expects that this should be possible within the next ten years.

One of the following steps to achieve this is the engineering of thicker muscle tissue, which the TU/e researchers will start working on in the near future. The same techniques will also have to be applied on human cells. "Researchers at the University Medical Center Groningen have already started, in partnership with us, to engineer human muscle tissue," Van der Schaft concludes.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by Eindhoven University of Technology.

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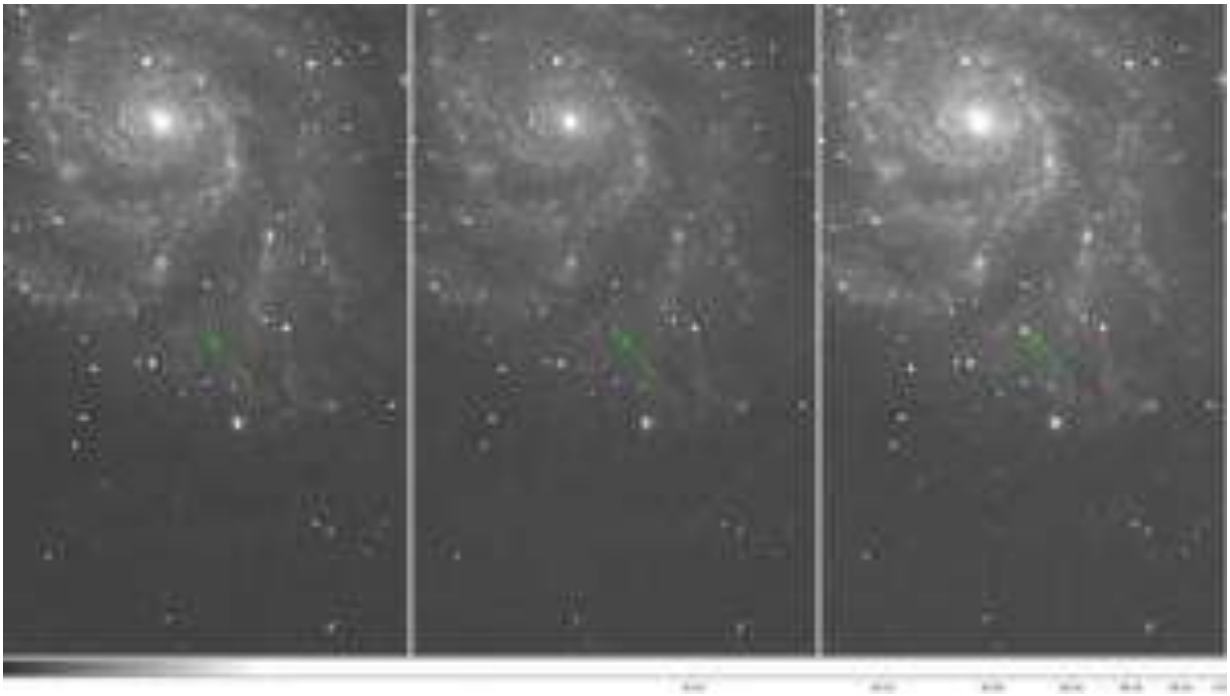
http://www.sciencedaily.com/releases/2011/08/110819080957.htm

Scientists Discover an 'Instant Cosmic Classic' Supernova



These images show Type Ia supernova PTF 11kly, the youngest ever detected -- over the past three nights. The left image taken on Aug. 22 shows the event before it exploded supernova, approximately one million times fainter than the human eye can detect. The center image taken on August 23 shows the supernova at about 10,000 times fainter than the human eye can detect. The right image taken on Aug. 24 shows that the event is six times brighter than the previous day. In two weeks time it should be visible with a good pair of binoculars. (Credit: Peter Nugent/LBNL and Palomar Observatory)

ScienceDaily (Aug. 25, 2011) — A supernova discovered August 24 is closer to Earth -- approximately 21 million light-years away -- than any other of its kind in a generation. Astronomers believe they caught the supernova within hours of its explosion, a rare feat made possible with a specialized survey telescope and state-of-the-art computational tools.

The finding of such a supernova so early and so close has energized the astronomical community as they are scrambling to observe it with as many telescopes as possible, including the Hubble Space Telescope.

Joshua Bloom, assistant professor of astronomy at the University of California, Berkeley, called it "the supernova of a generation." Astronomers at Lawrence Berkeley National Laboratory (Berkeley Lab) and UC Berkeley, who made the discovery predict that it will be a target for research for the next decade, making it one of the most-studied supernova in history.

The supernova, dubbed PTF 11kly, occurred in the Pinwheel Galaxy, located in the "Big Dipper," otherwise known as the Ursa Major constellation. It was discovered by the Palomar Transient Factory (PTF) survey, which is designed to observe and uncover astronomical events as they happen.

"We caught this supernova very soon after explosion. PTF 11kly is getting brighter by the minute. It's already 20 times brighter than it was yesterday," said Peter Nugent, the senior scientist at Berkeley Lab who first

spotted the supernova. Nugent is also an adjunct professor of astronomy at UC Berkeley. "Observing PTF 11kly unfold should be a wild ride. It is an instant cosmic classic."

He credits supercomputers at the National Energy Research Scientific Computing Center (NERSC), a Department of Energy supercomputing center at Berkeley Lab, as well as high-speed networks with uncovering this rare event in the nick of time.

The PTF survey uses a robotic telescope mounted on the 48-inch Samuel Oschin Telescope at Palomar Observatory in Southern California to scan the sky nightly. As soon as the observations are taken, the data travels more than 400 miles to NERSC via the National Science Foundation's High Performance Wireless Research and Education Network and DOE's Energy Sciences Network (ESnet). At NERSC, computers running machine learning algorithms in the Real-time Transient Detection Pipeline scan through the data and identify events to follow up on. Within hours of identifying PTF 11kly, this automated system sent the coordinates to telescopes around the world for follow-up observations.

Three hours after the automated PTF pipeline identified this supernova candidate, telescopes in the Canary Islands (Spain) had captured unique "light signatures," or spectra, of the event. Twelve hours later, his team had observed the event with a suite of telescopes including the Lick Observatory (California), and Keck Observatory (Hawaii) and determined the supernova belongs to a special category, called Type Ia. Nugent notes that this is the earliest spectrum ever taken of a Type Ia supernova.

"Type Ia supernova are the kind we use to measure the expansion of the Universe. Seeing one explode so close by allows us to study these events in unprecedented detail," said Mark Sullivan, the Oxford University team leader who was among the first to follow up on this detection.

"We still do not know for sure what causes such explosions," said Weidong Li, senior scientist at UC Berkeley and collaborator of Nugent. "We are using images from the Hubble Space Telescope, taken fortuitously years before an explosion to search for clues to the event's origin."

The team will be watching carefully over the next few weeks, and an urgent request to NASA yesterday means the Hubble Space Telescope will begin studying the supernova's chemistry and physics this weekend.

Catching supernovae so early allows a rare glimpse at the outer layers of the supernova, which contain hints about what kind of star exploded. "When you catch them this early, mixed in with the explosion you can actually see unburned bits from star that exploded! It is remarkable," said Andrew Howell of UC Santa Barbara/Las Cumbres Global Telescope Network. "We are finding new clues to solving the mystery of the origin of these supernovae that has perplexed us for 70 years. Despite looking at thousands of supernovae, I've never seen anything like this before."

"The ability to process all of this data in near real-time and share our results with collaborators around the globe through the Science Gateway at NERSC is an invaluable tool for following up on supernova events," says Nugent. "We wouldn't have been able to detect and observe this candidate as soon as we did without the resources at NERSC."

At a mere 21 million light-years from Earth, a relatively small distance by astronomical standards, the supernova is still getting brighter, and might even be visible with good binoculars in ten days' time, appearing brighter than any other supernova of its type in the last 30 years.

"The best time to see this exploding star will be just after evening twilight in the Northern hemisphere in a week or so," said Oxford's Sullivan. "You'll need dark skies and a good pair of binoculars, although a small telescope would be even better."

The scientists in the PTF have discovered more than 1,000 supernovae since it started operating in 2008, but they believe this could be their most significant discovery yet. The last time a supernova of this sort occurred so close was in 1986, but Nugent notes that this one was peculiar and heavily obscured by dust.

"'Before that, you'd have to go back to 1972, 1937 and 1572 to find more nearby Type Ia supernovae," says Nugent.

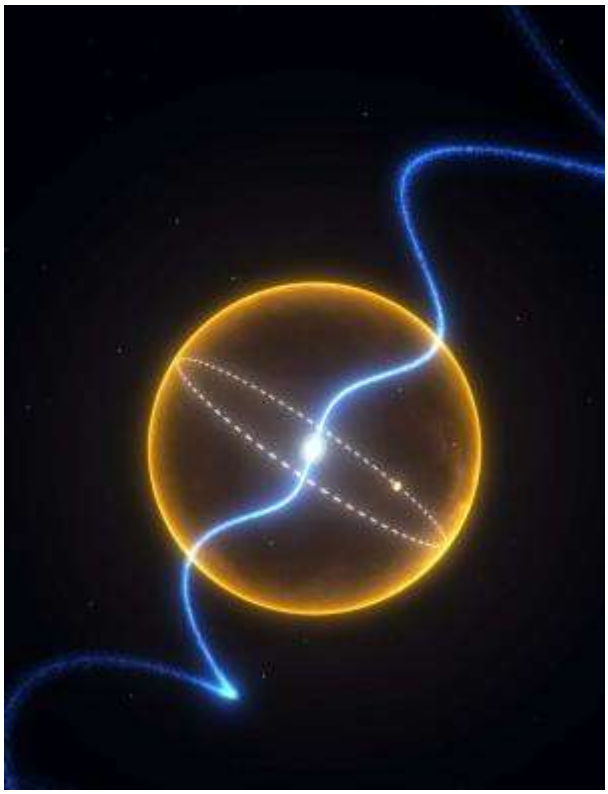
The Palomar Transient Factory is a survey operated a Palomar Observatory by the California Institute of Technology on behalf of a worldwide consortium of partner institutions. Collaborators on PTF 11kly with Nugent, Bloom and Li are Brad Cenko, Alex V. Filippenko, Geoffrey Marcy, Adam Miller (UC Berkeley), Rollin C. Thomas (Lawrence Berkeley National Laboratory), Sullivan (Oxford University), and Andrew Howell (UC Santa Barbara/Las Cumbres Global Telescope Network).

Read more about how NERSC supports the Palomar Transient Factory.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by DOE/Lawrence Berkeley National Laboratory.

http://www.sciencedaily.com/releases/2011/08/110825164936.htm

Pulsar Transformed Into Small Planet Made of Diamond Discovered in Milky Way



The pulsar at the centre of the below image is orbited by an object that is about the mass of Jupiter and composed primarily of carbon; effectively a massive diamond. The orbit, represented by the dashed line, would easily fit inside our Sun, represented by the yellow surface. The blue lines represent the radio signal from the pulsar, which spins around 175 times every second. (Credit: Swinburne Astronomy Productions)

ScienceDaily (Aug. 25, 2011) — A once-massive star that's been transformed into a small planet made of diamond: that's what astronomers think they've found in our Milky Way.

The discovery, reported in *Science*, was made by an international research team led by Professor Matthew Bailes, Pro Vice-Chancellor (Research) at Swinburne University of Technology in Melbourne and the 'Dynamic Universe' theme leader in a new wide-field astronomy initiative, the ARC Centre of Excellence for All-sky Astrophysics (CAASTRO).

The researchers, from Australia, Germany, Italy, the UK and the USA, first detected an unusual star called a pulsar using the CSIRO Parkes radio telescope and followed up their discovery with the Lovell radio telescope in the UK and one of the Keck telescopes in Hawaii.

Pulsars are small spinning stars about 20 km in diameter -- the size of a small city -- that emit a beam of radio waves. As the star spins and the radio beam sweeps repeatedly over Earth, radio telescopes detect a regular pattern of radio pulses.

For the newly discovered pulsar, known as PSR J1719-1438, the astronomers noticed that the arrival times of the pulses were systematically modulated. They concluded that this was due to the gravitational pull of a small companion planet, orbiting the pulsar in a binary system.

The pulsar and its planet are part of the Milky Way's plane of stars and lie 4,000 light-years away in the constellation of Serpens (the Snake). The system is about an eighth of the way towards the Galactic Centre from Earth.

The modulations in the radio pulses tell astronomers several things about the planet.

First, it orbits the pulsar in just two hours and ten minutes, and the distance between the two objects is 600,000 km -- a little less than the radius of our Sun.

Second, the companion must be small, less than 60,000 km (that's about five times Earth's diameter). The planet is so close to the pulsar that, if it were any bigger, it would be ripped apart by the pulsar's gravity.

But despite its small size, the planet has slightly more mass than Jupiter.

"This high density of the planet provides a clue to its origin," said Professor Bailes.

A star is torn

The team thinks that the 'diamond planet' is all that remains of a once-massive star, most of whose matter was siphoned off towards the pulsar.

Pulsar J1719-1438 is a very fast-spinning pulsar -- what's called a millisecond pulsar. Amazingly, it rotates more than 10,000 times per minute, has a mass of about 1.4 times that of our Sun but is only 20 km in diameter. About 70 per cent of millisecond pulsars have companions of some kind. Astronomers think it is the companion that, in its star form, transforms an old, dead pulsar into a millisecond pulsar by transferring matter and spinning it up to a very high speed. The result is a fast-spinning millisecond pulsar with a shrunken companion -- most often a so-called white dwarf.

"We know of a few other systems, called ultra-compact low-mass X-ray binaries, that are likely to be evolving according to this scenario and may likely represent the progenitors of a pulsar like J1719-1438," said team member Dr Andrea Possenti, Director of the INAF-Osservatorio Astronomico di Cagliari in Italy.

But pulsar J1719-1438 and its companion are so close together that the companion can only be a very stripped-down white dwarf, one that has lost its outer layers and over 99.9 per cent of its original mass.

"This remnant is likely to be largely carbon and oxygen, because a star made of lighter elements like hydrogen and helium would be too big to fit the measured orbiting times," said Dr Michael Keith (CSIRO), one of the research team members.

The density means that this material is certain to be crystalline: that is, a large part of the star may be similar to a diamond.

"The ultimate fate of the binary is determined by the mass and orbital period of the donor star at the time of mass transfer. The rarity of millisecond pulsars with planet-mass companions means that producing such 'exotic planets' is the exception rather than the rule, and requires special circumstances," said Dr Benjamin Stappers from the University of Manchester.

The team found pulsar J1719-1438 among almost 200,000 Gigabytes of data using special codes on supercomputers at Swinburne University of Technology, The University of Manchester, and the INAF-Osservatorio Astronomico di Cagliari..

The discovery was made during a systematic search for pulsars over the whole sky that also involves the 100 metre Effelsberg radio telescope of the Max-Planck-Institute for Radioastronomy (MPIfR) in Germany. "This is the largest and most sensitive survey of this type ever conducted. We expected to find exciting things, and it is great to see it happening. There is more to come!" said Professor Michael Kramer, Director of the MPIfR.

Professor Matthew Bailes is a member of the Centre for Astrophysics and Supercomputing at Swinburne which is uniquely resourced to process the torrents of data generated by telescopes and simulations.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by Swinburne University of Technology.

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http://www.sciencedaily.com/releases/2011/08/110825141632.htm

Interbreeding Between Modern Humans and Evolutionary Cousins Gave Healthy Immune System Boost to Human Genome, Study Finds

Laurent Abi-Rached, Paul Norman and Libby Guethlein are co-authors of research on how the genome of geographically-distinct human populations vary in the amount and type of immune-system genes inherited from evolutionary cousins, the Neanderthals and Denisovans. People in Papua New Guinea, for instance, have a particularly high percentage of one type of immune-system gene that is rarely found in people in Africa. (Credit: Norbert von der Groeben)

ScienceDaily (Aug. 25, 2011) — For a few years now, scientists have known that humans and their evolutionary cousins had some casual flings, but now it appears that these liaisons led to a more meaningful relationship.

Sex with Neanderthals and another close relative -- the recently discovered Denisovans -- has endowed some human gene pools with beneficial versions of immune system genes, report researchers at the Stanford University School of Medicine in an article to be published online by the journal *Science* at the Science Express website on Aug. 25.

Although modern humans, Neanderthals and Denisovans share a common ancestor in Africa, the groups split into separate, distinct populations approximately 400,000 years ago. The Neanderthal lineage migrated northwestward into West Asia and Europe, and the Denisovan lineage moved northeastward into East Asia. The ancestors of modern man stayed in Africa until 65,000 years or so ago, when they expanded into Eurasia and then encountered the other human-like groups. In some cases, the rendezvous were amorous in nature.

Last year, a partial genome sequence of Neanderthals, who died out approximately 30,000 years ago, revealed that these trysts left as much as 4 percent Neanderthal DNA in the genetic blueprint of some present-day humans. Last December, the genome of another human cousin, the extinct Denisovans, made clear that up to 6 percent of some people's genomes are Denisovan in origin.

Now, a team of researchers led by Peter Parham, PhD, professor of structural biology and of microbiology and immunology, has found that these matings had a positive effect on modern human fitness. "The cross breeding wasn't just a random event that happened, it gave something useful to the gene pool of the modern human," said Parham, who is senior author on the study.

The useful gift was the introduction of new variants of immune system genes called the HLA class I genes, which are critical for our body's ability to recognize and destroy pathogens. HLA genes are some of the most variable and adaptable genes in our genome, in part because the rapid evolution of viruses demands flexibility on the part of our immune system.

"The HLA gene system, with its diversity of variants, is like a magnifying glass," said lead author Laurent Abi-Rached, PhD, explaining that it provides a lot more detail about the history of populations than typical gene families. Abi-Rached is a research associate in the Parham lab.

Prior to the sequencing of the Neanderthal and Denisovan genomes, Parham and his group had suspected that at least one HLA variant came from archaic humans. They determined that the variant known as HLA-B*73 is rare in present-day African populations but occurs with significant frequency in West Asian populations. The ethnic distribution of HLA-B*73 and its similarity across populations suggested that it came from a relatively recent co-mingling of modern human and archaic human DNA, which most likely would have happened outside of Africa. Parham's team wanted to discern which archaic humans were the source of the HLA-B*73 gene type. In the last year they have found the answer in the genome sequence of a recently discovered human relative, the Denisovans, whose existence first came to light in 2008 with the discovery of an unfamiliar finger bone and tooth in a cave in Siberia.

By comparing the HLA genes of the archaic humans with modern humans, the researchers were able to show that the HLA-B*73 allele likely came from cross breeding with Denisovans. Little is known about what the Denisovans looked like (the finger bone and the tooth are the only known fossils), but the genome sequence extracted from the finger bone gives insight into where they overlapped with modern humans. Gene flow from the Denisovans into modern humans has left the highest frequency of the HLA-B*73 allele in populations in West Asia, the most likely site for the fortuitous mating to have taken place.

Even in West Asian populations, the HLA-B*73 variant never represents more than 5 percent of all known variants of that gene. However, other human HLA types that arose from ancient matings are found in much greater frequencies. "Certain traits coming from these archaic humans have become the dominant form," said Parham. For example, another HLA gene type, called HLA-A*11, is absent from African populations, but represents up to 64 percent of variants in East Asia and Oceania, with the greatest frequency in people from Papua New Guinea. "The likely interpretation was that these HLA class variants provided an advantage to modern human and so rose to high frequencies," Parham said.

A similar scenario is seen in some HLA gene types found in the Neanderthal genome, which was also sequenced from DNA extracted from ancient bones. These gene variants are common in European and Asian populations but rare in African populations. "We are finding frequencies in Asia and Europe that are far greater than whole genome estimates of archaic DNA in modern human genomes, which is 1 to 6 percent," said Parham. Within one class of HLA gene, the researchers estimate that Europeans owe half of their variants to interbreeding with Neanderthals and Denisovans, Asians owe up to 80 percent and Papua New Guineans, up to 95 percent.

"This is not the pattern seen genome-wide," said Abi-Rached. "The HLA system is unique in its diversity and the strength of natural selection acting on it, but it's possible that other gene systems, particularly the ones under similar pressure for variation, could show a similar pattern."

Other Stanford-affiliated authors include Matthew Jobin, PhD, lecturer in the Department of Anthropology; postdoctoral scholar Subhash Kulkarni, PhD; research assistant Farbod Babrzadeh; visiting scholar Baback Gharizadeh, PhD; and research associates Lisbeth Guethlein, PhD, and Paul Norman, PhD. The Stanford researchers collaborated with colleagues at the Royal Free Hospital, in the United Kingdom; Ankara University, in Turkey; the National Marrow Donor Program, in Minneapolis; the University of Manitoba; the University of Nairobi; the National Cancer Institute; Liverpool University; UCLA; Canadian Blood Services; and UC-Santa Cruz.

The study was funded by National Institutes of Health, the Yerkes Center, the National Science Foundation and the National Cancer Institute.

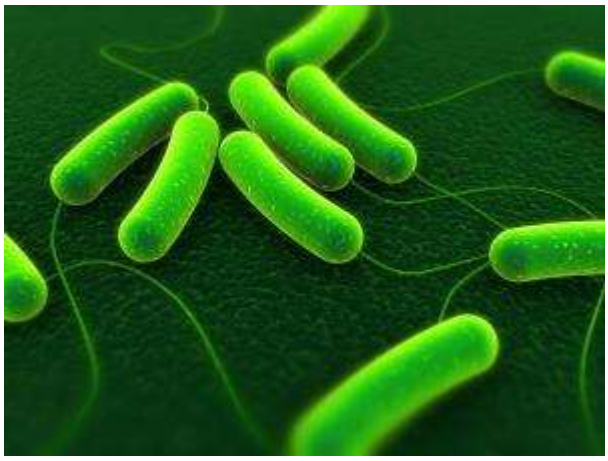
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by Stanford University Medical Center. The original article was written by Susan L. Young.

Journal Reference:

1. Laurent Abi-Rached, Matthew J. Jobin, Subhash Kulkarni, Alasdair McWhinnie, Klara Dalva, Loren Gragert, Farbod Babrzadeh, Baback Gharizadeh, Ma Luo, Francis A. Plummer, Joshua Kimani, Mary Carrington, Derek Middleton, Raja Rajalingam, Meral Beksac, Steven G. E. Marsh, Martin Maiers, Lisbeth A. Guethlein, Sofia Tavoularis, Ann-Margaret Little, Richard E. Green, Paul J. Norman, Peter Parham. The Shaping of Modern Human Immune Systems by Multiregional Admixture with Archaic Humans. *Science*, 2011; DOI: 10.1126/science.1209202

http://www.sciencedaily.com/releases/2011/08/110825141635.htm

Protein-Making Machinery in Bacteria Successfully Re-Engineered



Artist's rendering of E. coli bacteria. (Credit: iStockphoto/Sebastian Kaulitzki)

ScienceDaily (Aug. 25, 2011) — Yale University researchers have successfully re-engineered the protein-making machinery in bacteria, a technical *tour de force* that promises to revolutionize the study and treatment of a variety of diseases.

"Essentially, we have expanded the genetic code of *E. coli*, which allows us synthesize special forms of proteins that can mimic natural or disease states," said Jesse Rinehart of the Department of Cellular and Molecular Physiology and co-corresponding author of the research published in the Aug. 26 issue of the journal *Science*.

Since the structure of DNA was revealed in the 1950s, scientists have been working hard to understand the nature of the genetic code. Decades of research and recent advances in the field of synthetic biology have given researchers the tools to modify the natural genetic code within organisms and even rewrite the universal recipe for life.

"What we have done is taken synthetic biology and turned it around to give us real biology that has been synthesized," Rinehart explained.

The Yale team -- under the direction of Dieter Söll, Sterling Professor of Molecular Biophysics and Biochemistry, professor of chemistry and corresponding author of the paper -- developed a new way to influence the behavior of proteins, which carry out almost all of life's functions. Instead of creating something new in nature, the researchers essentially induced phosphorylation, a fundamental process that occurs in all forms of life and can dramatically change a protein's function. The rules for protein phosphorylation are not directly coded in the DNA but instead occur after the protein is made. The Yale researchers fundamentally rewrote these rules by expanding the *E. coli* genetic code to include phosphoserine, and for the first time directed protein phosphorylation via DNA.

This new technology now enables the production of human proteins with their naturally occurring phosphorylation sites, a state crucial to understanding disease processes. Previously, scientists lacked the ability to study proteins in their phosphorylated or active state. This has hindered research in diseases such as cancer, which is marked by damagingly high levels of protein activation.

"What we are doing is playing with biological switches -- turning proteins on or off -- which will give us a completely new way to study disease states and hopefully guide the discovery of new drugs," Rinehart said.

"We had to give some very ancient proteins a few modern upgrades," Söll said.

Söll and Rinehart now are attempting to create proteins in states known to be linked to cancer, type 2 diabetes, and hypertension. Both men, however, stressed the technique can be done for any type of protein.

"Dr. Söll and his colleagues have provided researchers with a powerful new tool to use in uncovering how cells regulate a broad range of processes, including cell division, differentiation and metabolism," said Michael Bender, who oversees protein synthesis grants at the National Institute of General Medical Sciences of the National Institutes of Health.

Other authors from Yale are lead authors Hee-Sung Park and Michael J. Hohn, Takuya Umehara and L-Tao Guo. They collaborated with Edith M. Osborne, Jack Benner, and Christopher J. Noren from New England Biolabs.

The work was funded by grants from the National Science Foundation and the National Institutes of Health via the National Institute of General Medical Sciences and the National Institute of Diabetes and Digestive and Kidney Diseases.

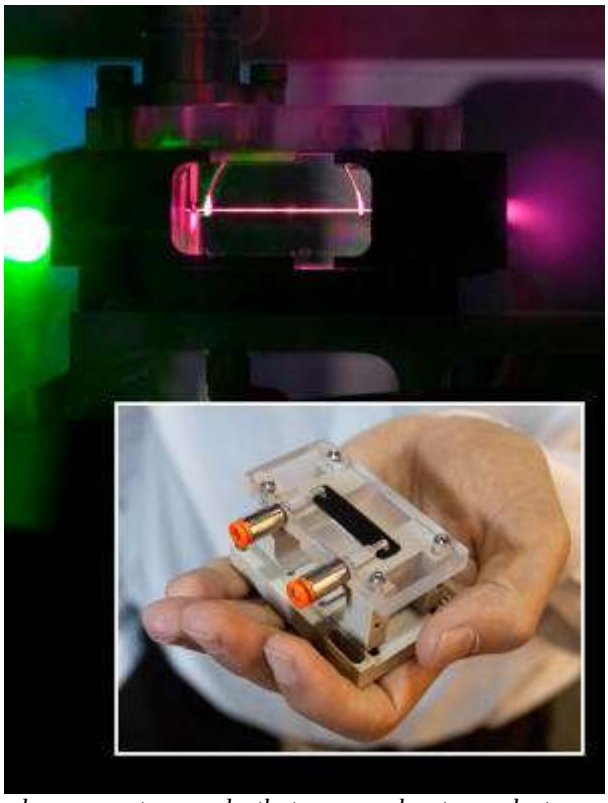
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by Yale University.

Journal Reference:

1. Hee-Sung Park, Michael J. Hohn, Takuya Umehara, Li-Tao Guo, Edith M. Osborne, Jack Benner, Christopher J. Noren, Jesse Rinehart, Dieter Söll. Expanding the Genetic Code of Escherichia coli with Phosphoserine. *Science*, 2011; 333 (6046): 1151-1154 DOI: 10.1126/science.1207203

http://www.sciencedaily.com/releases/2011/08/110825141630.htm

Beams to Order from Table-Top Accelerators



A laser pulse through a capillary filled with hydrogen plasma creates a wake that can accelerate an electron beam to a billion electron volts in just 3.3 centimeters. The same LOASIS accelerating structure has been modified to tune stable, high-quality beams from 100 to 400 million electron volts. (Credit: Photos by Roy Kaltschmidt, Berkeley Lab Public Affairs)

ScienceDaily (Aug. 25, 2011) — Laser plasma accelerators offer the potential to create powerful electron beams within a fraction of the space required by conventional accelerators -- and at a fraction of the cost. Their promise for the future includes not only compact high-energy colliders for fundamental physics but diminutive sources of intensely bright beams of light, spanning the spectrum from microwaves to gamma rays -- a new kind of ultrafast light source for investigating new materials, biological structures, and green chemistry.

Compared to today's giant science facilities, "table-top" laser plasma accelerators may eventually be able to do equally powerful research with minimal environmental impact.

To reach these goals, laser plasma accelerators must be able to produce high-quality, stable electron beams and tune those beams to the users' needs. The LOASIS program at the U.S. Department of Energy's Lawrence Berkeley National Laboratory (Berkeley Lab) has already demonstrated high-quality beams up to a billion electron volts in a mere 3.3 centimeters; the BELLA project will reach 10 billion electron volts in a single meter.

Now the LOASIS team has demonstrated a simple way to tune highly stable beams through a wide range of energies. They describe their methods in the journal *Nature Physics*.

Surfing the wave

"To describe how a laser plasma accelerator works, I use the analogy of a surfer riding a wave," says Wim Leemans, who heads the LOASIS program in Berkeley Lab's Accelerator and Fusion Research Division. "The surfers are the electrons themselves. The waves form when a laser pulse plows through a plasma."

In a plasma, atomic nuclei (ions) are separated from electrons, and immensely strong electric fields can build up between the oppositely charged particles when they are separated by the waves behind a powerful laser pulse. Some of the electrons in the plasma are swept up by the waves and are quickly accelerated to high energy.

"In this case the wave is a tsunami, and it doesn't much matter what the surfers do; they'll be carried along," Leemans says. "That's called self-trapping. But there are other ways a surfer can catch a wave. Real surfers can gauge the size and speed of an oncoming wave and start paddling to match its momentum."

Attempts to create tunable electron beams through momentum-matching have been tried, by injecting electrons into the accelerating field -- first giving them a boost using colliding laser pulses to catch the wave, then using a different drive-laser pulse to excite a wave on which those surfing electrons can be accelerated to high energies. It's an approach that demands sophisticated timing and synchronization, and along with other tuning methods for one-stage accelerators, requires electron injection that's localized in space and time.

"But there's a third way of helping a surfer catch a wave," Leemans says, "and that's by slowing the wave until even slow surfers can catch it -- then increasing the speed of the wave." In other words, a two-stage process -- and this turns out to be the secret to tunable, high-quality electron beams.

For their experiments the Berkeley Lab scientists modified the same 3.3-centimeter LOASIS accelerator and the same 40-trillion-watt peak-power drive laser, dubbed TREX, they used to produce the first billion-electron-volt beam. The accelerator is a block of titanium sapphire with a narrow capillary through it, filled with hydrogen gas that's ionized to a plasma by a jolt of electricity, just before the drive-laser pulse enters.

"Two-stage" acceleration

Slowing the laser wake and then speeding it up requires controlling the wake's phase velocity. To modify the LOASIS system for "two-stage," tunable acceleration, the researchers introduced a supersonic jet of helium gas that passes through the accelerator's hydrogen-filled capillary at the upstream front end. This sharply increases the density of electrons in the subsequent plasma. The plasma density then falls off rapidly downstream.

"The extra density itself serves as a lens to focus the laser to higher intensity, and the laser is focused right where the extra density is beginning to decrease," says Leemans. Here at the edge of the "density downramp," the slower waves trap electrons more readily. "The waves in the wake are falling farther behind the laser pulse as it enters the region of lower density."

Density control is only one way to control wave velocity, however. Another method is through laser intensity -- an unexpected gift from Albert Einstein's Special Theory of Relativity. Leemans explains, "The particles in the plasma waves have slowed because of the increased density, but they're still moving relativistically, near the speed of light,"

Carl Schroeder, a theoretician with LOASIS and an author of the *Nature Physics* paper, says that "as the laser is focused, its intensity increases, driving larger and larger plasma waves. Larger waves increase the relativistic mass effect. This reduces the frequency of the wave and stretches the wavelength. The peaks of the waves fall even farther behind the laser pulse."

Says experimenter Tony Gonsalves, first author of the *Nature Physics* paper, "If we simply end the plasma there, we have a stable low-energy accelerator. But with a second stage we can accelerate the electron beam to much higher energy, and we can tune that energy."

The same drive-laser pulse whose wake has been slowed by plasma density and laser intensity now powers into the low-density region of the accelerator; the following waves, carrying their extra load of electron "surfers," rapidly catch up.

"Tuning the energy is possible because by changing the density or location of the higher-density plasma, we can change its focusing power, the intensity of the laser pulse, and how much the pulse spreads out in the following lower-density plasma," Gonsalves says. "This allows us to tune the acceleration length and the final beam energy. The stability we achieve over our tunable range is quite amazing."

By tailoring plasma density in the two zones over the length of the accelerator, the LOASIS researchers were able to tune the energy of the electron beams over a range from 100 million electron volts to 400 million electron volts, while maintaining energy stability to within a few percent.

Leemans says, "Tailoring plasma density longitudinally this way is a concept that shows a new path to the level of sophisticated tuning for accelerators and light sources that users of conventional facilities just take for granted. It's a major step toward perfecting the laser plasma light sources and accelerators of the future."

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by DOE/Lawrence Berkeley National Laboratory.

Journal Reference:

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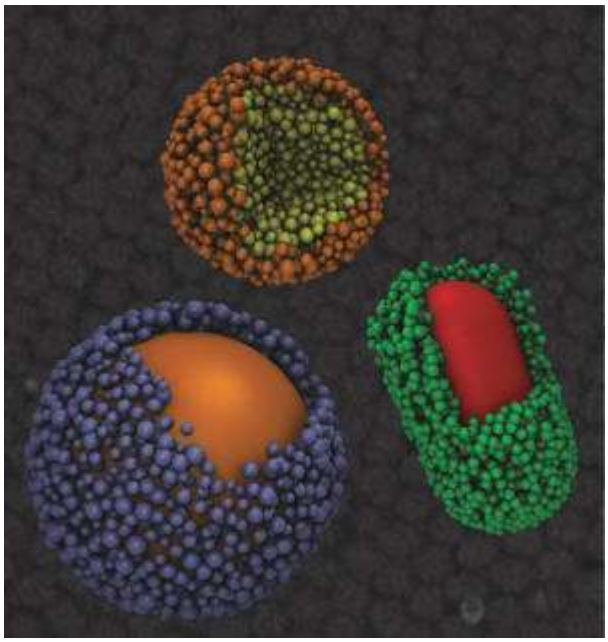
http://www.sciencedaily.com/releases/2011/08/110822135020.htm

Engineers Discover Nanoscale Balancing Act That Mirrors Forces at Work in Living Systems



Engineering researchers have discovered that under the right circumstances, basic atomic forces can be exploited to enable nanoparticles to assemble into superclusters that are uniform in size and share attributes with viruses. (Credit: T.D.Nguyen, Glotzer Group, University of Michigan)

ScienceDaily (Aug. 25, 2011) — A delicate balance of atomic forces can be exploited to make nanoparticle superclusters that are uniform in size -- an attribute that's important for many nanotech applications but hard to accomplish, University of Michigan researchers say.

The same type of forces are at work bringing the building blocks of viruses together, and the inorganic supercluster structures in this research are in many ways similar to viruses.

U-M chemical engineering professors Nicholas Kotov and Sharon Glotzer led the research. The findings are newly published online in *Nature Nanotechnology*.

In another instance of forces behaving in unexpected ways at the nanoscale, they discovered that if you start with small nanoscale building blocks that are varied enough in size, the electrostatic repulsion force and van der Waals attraction force will balance each other and limit the growth of the clusters. This equilibrium enables the formation of clusters that are uniform in size.

"The breakthrough here is that we've discovered a generic mechanism that causes these nanoparticles to assemble into near perfect structures," Glotzer said. "The physics that we see is not special to this system, and could be exploited with other materials. Now that we know how it works, we can design new building blocks that will assemble the same way."

The inorganic superclusters -- technically called "supraparticles" -- that the researchers created out of red, powdery cadmium selenide are not artificial viruses. But they do share many attributes with the simplest forms of life, including size, shape, core-shell structure and the abilities to both assemble and dissemble, Kotov said.

"Having these functionalities in totally inorganic system is quite remarkable," Kotov said. "There is the potential to combine them with the beneficial properties of inorganic materials such as environmental resilience, light adsorption and electrical conductivity."

Zhiyong Tang, a collaborating professor at the National Center of Nanoscience and Technology in China, said, "It is also very impressive that such supraparticles can be further used as the building blocks to fabricate three-dimensional ordered assemblies. This secondary self-assembly behavior provides a feasible way to obtain large-scale nanostructures that are important for practical application."

Kotov is currently working on "breeding" these supraparticles to produce synthetic fuels from carbon dioxide. The work also has applications in drug delivery and solar cell research and it could dramatically reduce the cost of manufacturing large quantities of supraparticles.

"By replicating the self-assembly processes that allow living organisms to grow and heal, we can simplify the production of many useful nanostructured systems from semiconductors and metals so much so that they can be made in any high school laboratory," Kotov said.

This research is funded by the Department of Defense, the National Science Foundation and the U.S. Army Research Office.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by University of Michigan.

Journal Reference:

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http://www.sciencedaily.com/releases/2011/08/110823180520.htm

Gene Study Sheds New Light On Origins of British Men

Changing of the Guards ceremony at Buckingham Palace in London, UK. (Credit: iStockphoto/Birute Vijeikiene)

ScienceDaily (Aug. 25, 2011) — New genetic evidence reveals that most British men are not descended from immigrant farmers who migrated east 5,000-10,000 years ago -- contrary to previous research.

Instead, scientists from the Universities of Oxford and Edinburgh say that most European men can trace their lineage to people -- most likely hunter-gatherers -- who had settled in Europe long before that time.

The latest study, based on the most common genetic lineage in European males, aims to correct an analysis of genetic data, published last year. It had reported that most British men came from people who migrated west, with the spread of agriculture, from the Near East.

More than 100 million European men have a set of genes called R-M269, including about three-quarters of British men. A key question in understanding the peopling of Europe is when this group spread out across Europe.

Researchers say their work shows that the set of genes chosen to estimate the age of this group of men vary the outcome enormously. They add that the previously reported east-west pattern is not found in their larger and more comprehensive dataset. This, the Oxford-Edinburgh team says, leaves little evidence for a farmer-led dispersal of this major group.

According to Dr Cristian Capelli, the Oxford geneticist who led the research, the study "resets" the debate on the peopling of Europe. He says, "Our works overturns the recent claims of European Y chromosomes being brought into the continent by farmers."

Co-author, Dr Jim Wilson of the University of Edinburgh's Centre for Population Health Sciences, adds that the paper shows for the first time that certain properties of the genes studied strongly influence the accuracy of the date estimate.

"Estimating a date at which an ancestral lineage originated is an interesting application of genetics, but unfortunately it is beset with difficulties and it is very difficult to provide good dates. Many people assume that the more genes the more accurate the dates, but this is not the case: some genetic markers are more suited to dating than others."

The study also reports multiple subgroups of the R-M269 group that are very common in different parts of Europe, consistent with expansion of these different groups in each place.

The study is published online in the *Proceedings of the Royal Society B: Biological Sciences*.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by University of Edinburgh.

Journal Reference:

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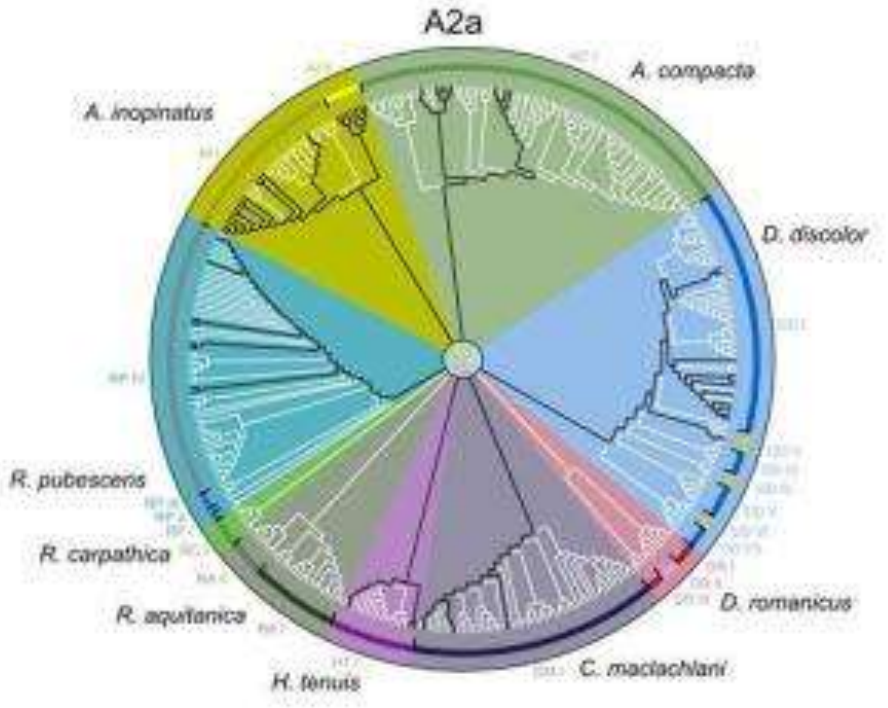
http://www.sciencedaily.com/releases/2011/08/110824214601.htm

Global Warming May Cause Higher Loss of Biodiversity Than Previously Thought



White branches show lost genetic lineages (no climatically suitable areas projected) in 2080 if global temperature increases by four degrees. (Credit: Copyright Miklos Bálint et al)

ScienceDaily (Aug. 24, 2011) — If global warming continues as expected, it is estimated that almost a third of all flora and fauna species worldwide could become extinct. Scientists from the Biodiversity and Climate Research Centre (Biodiversität und Klima Forschungszentrum, BiK-F) and the SENCKENBERG Gesellschaft für Naturkunde discovered that the proportion of actual biodiversity loss should quite clearly be revised upwards: by 2080, more than 80 % of genetic diversity within species may disappear in certain groups of organisms, according to researchers in the title story of the journal *Nature Climate Change*. The study is the first world-wide to quantify the loss of biological diversity on the basis of genetic diversity.

Most common models on the effects of climate change on flora and fauna concentrate on "classically" described species, in other words groups of organisms that are clearly separate from each other morphologically. Until now, however, so-called cryptic diversity has not been taken into account. It encompasses the diversity of genetic variations and deviations within described species, and can only be researched fully since the development of molecular-genetic methods. As well as the diversity of ecosystems and species, these genetic variations are a central part of global biodiversity.

In a pioneering study, scientists from the Biodiversity and Climate Research Centre (BiK-F) and the Senckenberg Gesellschaft für Naturkunde have now examined the influence of global warming on genetic diversity within species.

Over 80 percent of genetic variations may become extinct

The distribution of nine European aquatic insect species, which still exist in the headwaters of streams in many high mountain areas in Central and Northern Europe, was modelled. They have already been widely researched, which means that the regional distribution of the inner-species diversity and the existence of morphologically cryptic, evolutionary lines are already known.

If global warming does take place in the range that is predicted by the Intergovernmental Panel on Climate Change (IPCC), these creatures will be pushed back to only a few small refugia, e.g. in Scandinavia and the Alps, by 2080, according to model calculations. If Europe's climate warms up by up to two degrees only, eight of the species examined will survive, at least in some areas; with an increase in temperature of 4 degrees, six species will probably survive in some areas by 2080. However, due to the extinction of local populations, genetic diversity will decline to a much more dramatic extent.

According to the most pessimistic projections, 84 percent of all genetic variations would die out by 2080; in the "best case," two-thirds of all genetic variations would disappear. The aquatic insects that were examined are representative for many species of mountainous regions of Central Europe.

Slim chances in the long term for the emergence of new species and species survival

Carsten Nowak of the Biodiversity and Climate Research Centre (BiK-F) and the Senckenberg Gesellschaft für Naturkunde, explains: "Our models of future distribution show that the "species" as such will usually survive. However, the majority of the genetic variations, which in each case exist only in certain places, will not survive. This means that self-contained evolutionary lineages in other regions such as the Carpathians, Pyrenees or the German Central Uplands will be lost. Many of these lines are currently in the process of developing into separate species, but will become extinct before this is achieved, if our model calculations are accurate."

Genetic variation within a species is also important for adaptability to changing habitats and climatic conditions. Their loss therefore also reduces the chances for species survival in the long term.

New approach for conservation

So the extinction of species hides an ever greater loss, in the form of the massive disappearance of genetic diversity. "The loss of biodiversity that can be expected in the course of global warming has probably been greatly underestimated in previous studies, which have only referred to species numbers," says Steffen Pauls, Biodiversity and Climate Research Centre (BiK-F), of the findings. However, there is also an opportunity to use genetic diversity in order to make conservation and environmental protection more efficient.

A topic that is subject to much discussion at present is how to deal with conservation areas under the conditions of climate change. The authors of the study urge that conservation areas should also be oriented to places where both a suitable habitat for the species and a high degree of inner-species genetic diversity can be preserved in the future. "It is high time," says Nowak, "that we see biodiversity not only as a static accumulation of species, but rather as a variety of evolutionary lines that are in a constant state of change. The loss of one such line, irrespective of whether it is defined today as a "species" in itself, could potentially mean a massive loss in biodiversity in the future."

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by Senckenberg Research Institute and Natural History Museum, via AlphaGalileo.

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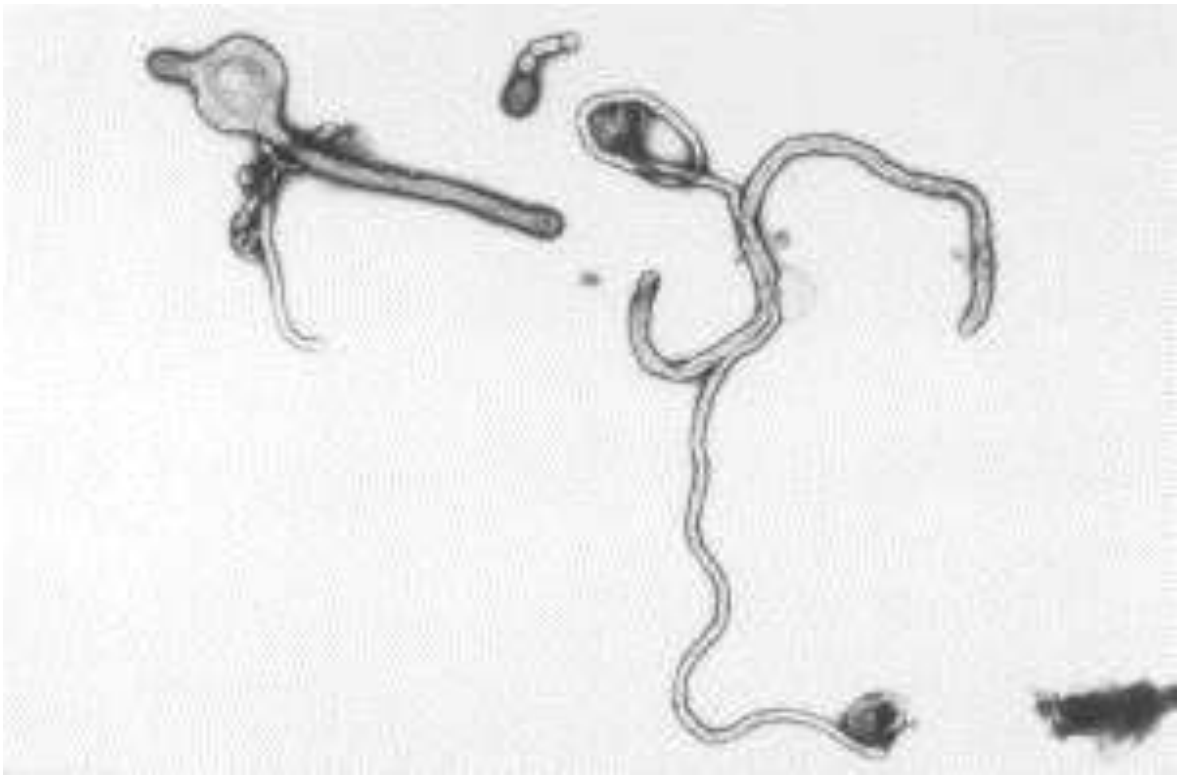
http://www.sciencedaily.com/releases/2011/08/110824091146.htm

Scientists Identify Point of Entry for Deadly Ebola Virus



This negatively-stained transmission electron micrograph (TEM) revealed some of the ultrastructural curvilinear morphologic features displayed by the Ebola virus discovered from the Ivory Coast of Africa. (Credit: Charles Humphrey)

ScienceDaily (Aug. 24, 2011) — Ebola virus, the cause of Ebola hemorrhagic fever (EHF), is one of the deadliest known viruses affecting humans. Like anthrax and smallpox virus, Ebola virus is classified by the U.S. Centers for Disease Control and Prevention (CDC) as a category A bioterrorism agent. Currently, there is no vaccine to prevent EHF, and patients are treated only for their symptoms.Although outbreaks are rare, Ebola virus, the cause of Ebola hemorrhagic fever (EHF), is one of the deadliest known viruses affecting humans. According to the World Health Organization (WHO), approximately 1,850 EHF cases with more than 1,200 deaths have been documented since the virus was identified in 1976.

EHF's clinical presentation can be devastating: fever, intense weakness, and joint and muscle aches progress to diarrhea, vomiting, and in some cases, internal and external bleeding caused by disintegrating blood vessels. Currently, there is no approved vaccine and patients are treated only for their symptoms. Like anthrax and smallpox virus, Ebola virus is classified as a category A bioterrorism agent by the U.S. Centers for Disease Control and Prevention (CDC).

Until now, however, researchers had only a limited understanding of how Ebola virus gains entry to a host cell.

Using an unusual human cell line, Whitehead Institute scientists and collaborators from Harvard Medical School, Albert Einstein College of Medicine and U.S. Army Medical Research Institute of Infectious Diseases, have identified the Niemann-Pick C1 (NPC1) protein as crucial for Ebola virus to enter cells and

begin replicating. The discovery may offer a new and better approach for the development of antiviral therapeutics, as it would target a structure in the host cell rather than a viral component.

The findings are reported online in *Nature* this week.

Where all of us inherit one copy of each chromosome from each of our two parents, cell lines exist with only a single set, and thus with a single copy of each individual gene, instead of the usual two. Using an unusual human cell line of this type, Whitehead Institute researchers and their collaborators performed a genetic screen and identified a protein used by Ebola virus to gain entry into cells and begin replicating. The discovery may offer a new approach for the development of antiviral therapeutics.

"Right now, people make therapeutics to inactivate the pathogen itself. But the problem is that pathogens can quickly change and escape detection and elimination by the immune system," says former Whitehead Fellow Thijn Brummelkamp, now a group leader at the Netherlands Cancer Institute (NKI). "Here we get a good idea of the host genes that are needed for the pathogen to enter the cell for replication. Perhaps by generating therapeutics against those host factors, we would have a more stable target for antiviral drugs."

The method developed by the Brummelkamp lab to identify host factors relies on gene disruption -- knocking out gene function in the host cells, one gene at a time -- and documenting which cells survive due to mutations that afford protection from viral entry.

But human cells are diploid with two copies of each chromosome and its genes. Researchers can reliably target and knock out one copy of a gene, but doing so for both copies is far more difficult and time-consuming. If only a single copy is silenced, the other continues to function normally and masks any effect of the knockout.

To sidestep this obstacle, Jan Carette, a first co-author on the *Nature* paper and a former postdoctoral researcher in the Brummelkamp lab, employed a technique he had previously applied to study the cytolethal distending toxin (CDT) family that is secreted by multiple pathogenic bacteria, including Escherichia coli, Shigella dysenteriae, and Haemophilus ducreyi. Each bacterial species has developed its own twists on the CDT structure, which may link to the target tissues of the toxin's bacterium.

In his CDT work published in *Nature Biotechnology*, Carette together with co-lead authors of Whitehead Member Hidde Ploegh's lab, used a line of haploid cells isolated from a chronic myeloid leukemia (CML) patient. Because these cells, called KBM7 cells, have only one copy of each chromosome except chromosome 8, the researchers could disrupt the expression of each gene and screen for mutants with the desired properties, in this case survival of a lethal dose of toxin.

After knocking out individual genes by disrupting the normal structure of the gene, the resulting mutant KBM7 cells were exposed to various CDTs. In the cells that survived, Carette and coauthors knew that genes that had been disrupted were somehow crucial to CDT intoxication. By analyzing the surviving cell's genomes, Carette and coauthors identified ten human proteins that are used by CDTs during intoxication, and those host factors seem to be tailored to each CDT's targeted cell.

"I found it surprising that there is quite some specificity in the entry routes for each toxin," says Carette. "If you take CDTs that are very similar to each other in structure, you could still see significant differences in the host factors they require to do their job. So it seems that every pathogen evolved a specific and unique way of its toxin entering the cells."

To study Ebola virus, Carette and co-lead authors from Harvard Medical School and the Albert Einstein College of Medicine made use of an otherwise harmless virus cloaked in the Ebola virus glycoprotein coat.

Using this virus and by altering the haploid cells somewhat, Carette and coauthors were able to pinpoint the cellular genes that Ebola virus relies on to enter the cell.

Carette and coauthors identified as necessary for Ebola virus entry several genes involved in organelles that transport and recycle proteins. One gene in particular stood out, NPC1, which codes for a cholesterol transport protein, and is necessary for the virus to enter the cell's cytoplasm for replication. Mutations in this gene cause a form of Niemann-Pick disease, an ultimately fatal neurological disorder diagnosed mainly in children.

Collaborators at the U.S. Army Medical Research Institute of Infectious Diseases (USAMRIID) tested the effects of active Ebola virus on mice that had one copy of the NPC1 gene knocked out. Control mice, with two functioning copies of the NPC1 gene, quickly succumbed to infection, while the NPC1 knockout mice were largely protected from the virus.

"This is pretty unexpected," says Carette, who is currently an Acting Assistant Professor in Microbiology & Immunology at Stanford School of Medicine. "This might imply that genetic mutations in the NPC1 gene in humans could make some people resistant to this very deadly virus. And now that we know that NPC1 is an Ebola virus host factor, it provides a strong platform from which to start developing new antivirals."

This research was supported by the National Institutes of Health (NIH), the U.S. Army, Boehringer Ingelheim Fonds and a Burroughs Wellcome Award.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by Whitehead Institute for Biomedical Research. The original article was written by Nicole Giese.

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http://www.sciencedaily.com/releases/2011/08/110824131549.htm

Discovery of a 160-Million-Year-Old Fossil Represents a New Milestone in Early Mammal Evolution

***Juramaia sinensis* - the earliest-known eutherian**
Photo: Dr. Zhe-Xi Luo / Carnegie Museum of Natural History

New Jurassic eutherian mammal Juramaia sinensis: The original fossil (type specimen) is preserved on a shale slab from the Jurassic Tiaojishan Formation. The fossil belongs to the Beijing Museum of Natural History (BMNH PM1143) and is being jointly studied by Chinese and American scientists. Etymology: "Jura" represents the Jurassic Period of the geological time scale; "-maia" means "mother;" sinensis means "from China." The full name means "Jurassic mother from China." (Credit: Zhe-Xi Luo/Carnegie Museum of Natural History)

ScienceDaily (Aug. 24, 2011) — A remarkably well-preserved fossil discovered in northeast China provides new information about the earliest ancestors of most of today's mammal species -- the placental mammals. According to a paper published August 25 in the journal *Nature*, this fossil represents a new milestone in mammal evolution that was reached 35 million years earlier than previously thought, filling an important gap in the fossil record and helping to calibrate modern, DNA-based methods of dating the evolution.

The paper by a team of scientists led by Carnegie Museum of Natural History paleontologist Zhe-Xi Luo describes *Juramaia sinensis*, a small shrew-like mammal that lived in China 160 million years ago during the Jurassic period. *Juramaia* is the earliest known fossil of eutherians -- the group that evolved to include all placental mammals, which provide nourishment to unborn young via a placenta. As the earliest known fossil ancestral to placental mammals, *Juramaia* provides fossil evidence of the date when eutherian mammals diverged from other mammals: metatherians (whose descendants include marsupials such as kangaroos) and monotremes (such as the platypus). As Luo explains, "*Juramaia*, from 160 million years ago, is either a great-grand-aunt, or a 'great-grandmother' of all placental mammals that are thriving today."

The "Jurassic mother from China"

The fossil of *Juramaia sinensis* was discovered in the Liaoning Province in northeast China and examined in Beijing by Zhe-Xi Luo and his collaborators: Chong-Xi Yuan and Qiang Ji from the Chinese Academy of Geological Sciences, and Qing-Jin Meng from the Beijing Museum of Natural History, where the fossil is stored. The name *Juramaia sinensis* means "Jurassic mother from China." The fossil has an incomplete skull, part of the skeleton, and, remarkably, impressions of residual soft tissues such as hair. Most importantly, *Juramaia*'s complete teeth and forepaw bones enable paleontologists to pin-point that it is closer to living placentals on the mammalian family tree than to the pouched marsupials, such as kangaroos.

Resetting the evolutionary clock

"Understanding the beginning point of placentals is a crucial issue in the study of all mammalian evolution," says Luo. The date of an evolutionary divergence -- when an ancestor species splits into two descendant lineages -- is among the most important pieces of information an evolutionary scientist can have. Modern molecular studies, such as DNA-based methods, can calculate the timing of evolution by a "molecular clock." But the molecular clock needs to be cross-checked and tested by the fossil record. Prior to the discovery of *Juramaia*, the divergence point of eutherians from metatherians posed a quandary for evolutionary historians: DNA evidence suggested that eutherians should have shown up earlier in the fossil record -- around 160 million years ago. Yet, the oldest known eutherian, was *Eomaia**, dated to 125 million years ago. The discovery of *Juramaia* gives much earlier fossil evidence to corroborate the DNA findings, filling an important gap in the fossil record of early mammal evolution and helping to establish a new milestone of evolutionary history.

Juramaia also reveals adaptive features that may have helped the eutherian newcomers to survive in a tough Jurassic environment. *Juramaia*'s forelimbs are adapted for climbing; since the majority of the Jurassic mammals lived exclusively on the ground, the ability to escape to the trees and explore the canopy might have allowed eutherian mammals to exploit an untapped niche.

Luo supports this perspective: "The divergence of eutherian mammals from marsupials eventually led to placental birth and reproduction that are so crucial for the evolutionary success of placentals. But it is their early adaptation to exploit niches on the tree that paved their way toward this success."

**Eomaia* was originally described in 2002 by a team of scientists led by Zhe-Xi Luo and Carnegie mammalogist John Wible.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by Carnegie Museum of Natural History, via EurekAlert!, a service of AAAS.

Journal Reference:

1. Zhe-Xi Luo, Chong-Xi Yuan, Qing-Jin Meng, Qiang Ji. A Jurassic eutherian mammal and divergence of marsupials and placentals. *Nature*, 2011; 476 (7361): 442 DOI: 10.1038/nature10291

http://www.sciencedaily.com/releases/2011/08/110824131535.htm

NASA's WISE Mission Discovers Coolest Class of Stars

This artist's conception illustrates what a "Y dwarf" might look like. Y dwarfs are the coldest star-like bodies known, with temperatures that can be even cooler than the human body. (Credit: NASA/JPL-Caltech)

ScienceDaily (Aug. 24, 2011) — Scientists using data from NASA's Wide-field Infrared Survey Explorer (WISE) have discovered the coldest class of star-like bodies, with temperatures as cool as the human body.

Astronomers hunted these dark orbs, termed Y dwarfs, for more than a decade without success. When viewed with a visible-light telescope, they are nearly impossible to see. WISE's infrared vision allowed the telescope to finally spot the faint glow of six Y dwarfs relatively close to our sun, within a distance of about 40 light-years.

"WISE scanned the entire sky for these and other objects, and was able to spot their feeble light with its highly sensitive infrared vision," said Jon Morse, Astrophysics Division director at NASA Headquarters in Washington. "They are 5,000 times brighter at the longer infrared wavelengths WISE observed from space than those observable from the ground."

The Y's are the coldest members of the brown dwarf family. Brown dwarfs are sometimes referred to as "failed" stars. They are too low in mass to fuse atoms at their cores and thus don't burn with the fires that keep stars like our sun shining steadily for billions of years. Instead, these objects cool and fade with time, until what little light they do emit is at infrared wavelengths.

Astronomers study brown dwarfs to better understand how stars form, and to understand the atmospheres of planets beyond our solar system. The atmospheres of brown dwarfs are similar to those of gas-giant planets

like Jupiter, but they are easier to observe because they are alone in space, away from the blinding light of a parent star.

So far, WISE data have revealed 100 new brown dwarfs. More discoveries are expected as scientists continue to examine the enormous quantity of data from WISE. The telescope performed the most advanced survey of the sky at infrared wavelengths to date, from Jan. 2010 to Feb. 2011, scanning the entire sky about 1.5 times.

Of the 100 brown dwarfs, six are classified as cool Y's. One of the Y dwarfs, called WISE 1828+2650, is the record holder for the coldest brown dwarf, with an estimated atmospheric temperature cooler than room temperature, or less than about 80 degrees Fahrenheit (25 degrees Celsius).

"The brown dwarfs we were turning up before this discovery were more like the temperature of your oven," said Davy Kirkpatrick, a WISE science team member at the Infrared Processing and Analysis Center at the California Institute of Technology in Pasadena, Calif. "With the discovery of Y dwarfs, we've moved out of the kitchen and into the cooler parts of the house."

Kirkpatrick is lead author of a paper appearing in the *Astrophysical Journal Supplement Series*, describing the 100 confirmed brown dwarfs. Michael Cushing, a WISE team member at NASA's Jet Propulsion Laboratory in Pasadena, Calif., is lead author of a paper describing the Y dwarfs in the *Astrophysical Journal*.

The Y dwarfs are in our sun's neighborhood, from approximately nine to 40 light-years away. The Y dwarf approximately nine light-years away, WISE 1541-2250, may become the seventh closest star system, bumping Ross 154 back to eighth. By comparison, the star closest to our solar system, Proxima Centauri, is about four light-years away.

"Finding brown dwarfs near our sun is like discovering there's a hidden house on your block that you didn't know about," Cushing said. "It's thrilling to me to know we've got neighbors out there yet to be discovered. With WISE, we may even find a brown dwarf closer to us than our closest known star."

Once the WISE team identified brown dwarf candidates, they turned to NASA's Spitzer Space Telescope to narrow their list. To definitively confirm them, the WISE team used some of the most powerful telescopes on Earth to split apart the objects' light and look for telltale molecular signatures of water, methane and possibly ammonia. For the very coldest of the new Y dwarfs, the team used NASA's Hubble Space Telescope. The Y dwarfs were identified based on a change in these spectral features compared to other brown dwarfs, indicating they have a lower atmospheric temperature.

The ground-based telescopes used in these studies include the NASA Infrared Telescope Facility atop Mauna Kea, Hawaii; Caltech's Palomar Observatory near San Diego; the W.M. Keck Observatory atop Mauna Kea, Hawaii; and the Magellan Telescopes at Las Campanas Observatory, Chile, among others.

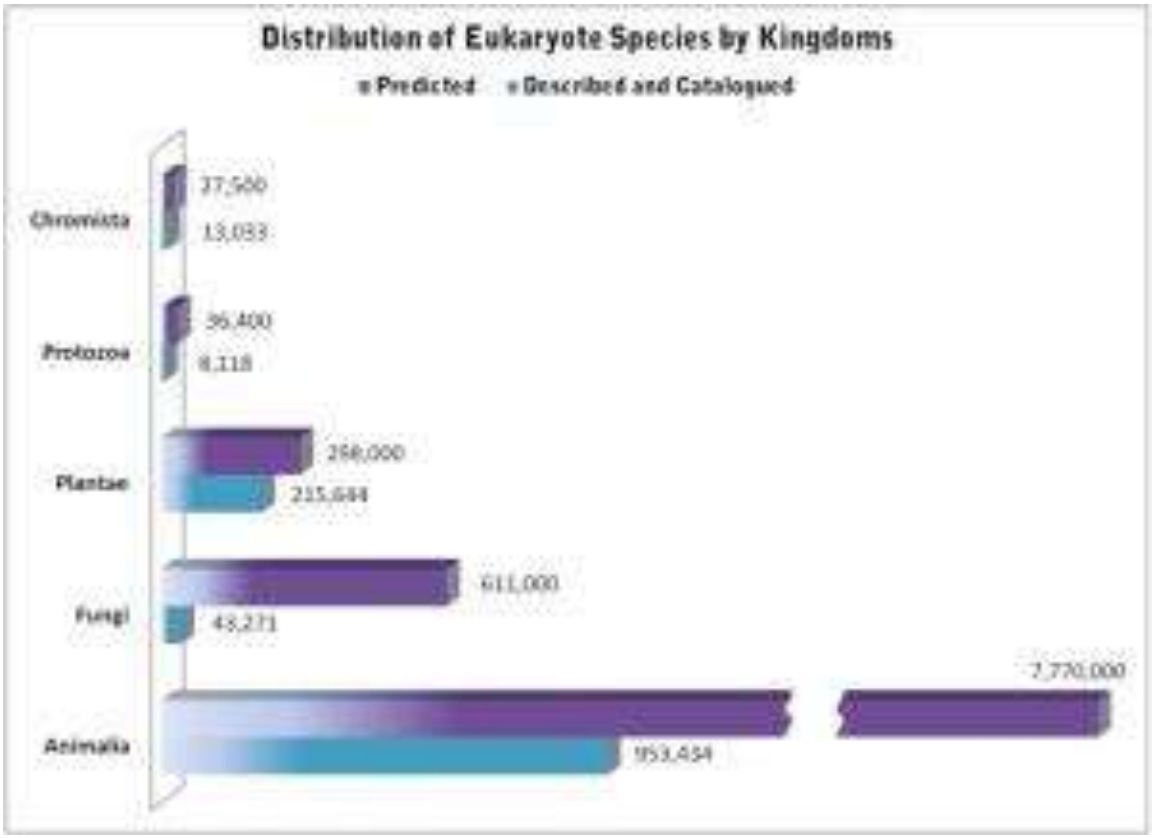
JPL manages WISE for NASA's Science Mission Directorate. The principal investigator is Edward Wright at UCLA. The WISE satellite was decommissioned in 2011 after completing its sky survey observations. The mission was selected under NASA's Explorers Program managed by the Goddard Space Flight Center in Greenbelt, Md. The science instrument was built by the Space Dynamics Laboratory in Logan, Utah, and the spacecraft by Ball Aerospace & Technologies Corp., in Boulder, Colo. Science operations and data processing are at the Infrared Processing and Analysis Center at the California Institute of Technology. JPL is a division of the California Institute of Technology in Pasadena.

More information is online at http://www.nasa.gov/wise , http://wise.astro.ucla.edu and http://jpl.nasa.gov/wise .

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by NASA/Jet Propulsion Laboratory.

http://www.sciencedaily.com/releases/2011/08/110824102135.htm

How Many Species On Earth? About 8.7 Million, New Estimate Says



Distribution of species by kingdom. (Credit: CoML)

ScienceDaily (Aug. 24, 2011) — Eight million, seven hundred thousand species (give or take 1.3 million).

That is a new, estimated total number of species on Earth -- the most precise calculation ever offered -- with 6.5 million species found on land and 2.2 million (about 25 percent of the total) dwelling in the ocean depths.

Announced today by Census of Marine Life scientists, the figure is based on an innovative, validated analytical technique that dramatically narrows the range of previous estimates. Until now, the number of species on Earth was said to fall somewhere between 3 million and 100 million.

Furthermore, the study, published by *PLoS Biology*, says a staggering 86% of all species on land and 91% of those in the seas have yet to be discovered, described and catalogued.

Says lead author Camilo Mora of the University of Hawaii and Dalhousie University in Halifax, Canada: "The question of how many species exist has intrigued scientists for centuries and the answer, coupled with research by others into species' distribution and abundance, is particularly important now because a host of human activities and influences are accelerating the rate of extinctions. Many species may vanish before we even know of their existence, of their unique niche and function in ecosystems, and of their potential contribution to improved human well-being."

"This work deduces the most basic number needed to describe our living biosphere," says co-author Boris Worm of Dalhousie University. "If we did not know -- even by an order of magnitude (1 million? 10 million? 100 million?) -- the number of people in a nation, how would we plan for the future?"

"It is the same with biodiversity. Humanity has committed itself to saving species from extinction, but until now we have had little real idea of even how many there are."

Dr. Worm notes that the recently-updated Red List issued by the International Union for the Conservation of Nature assessed 59,508 species, of which 19,625 are classified as threatened. This means the IUCN Red List, the most sophisticated ongoing study of its kind, monitors less than 1% of world species.

The research is published alongside a commentary by Lord Robert May of Oxford, past-president of the UK's Royal Society, who praises the researchers' "imaginative new approach."

"It is a remarkable testament to humanity's narcissism that we know the number of books in the US Library of Congress on 1 February 2011 was 22,194,656, but cannot tell you -- to within an order-of-magnitude -- how many distinct species of plants and animals we share our world with," Lord May writes.

"(W)e increasingly recognize that such knowledge is important for full understanding of the ecological and evolutionary processes which created, and which are struggling to maintain, the diverse biological riches we are heir to. Such biodiversity is much more than beauty and wonder, important though that is. It also underpins ecosystem services that -- although not counted in conventional GDP -- humanity is dependent upon."

Drawing conclusions from 253 years of taxonomy since Linnaeus

Swedish scientist Carl Linnaeus created and published in 1758 the system still used to formally name and describe species. In the 253 years since, about 1.25 million species -- roughly 1 million on land and 250,000 in the oceans -- have been described and entered into central databases (roughly 700,000 more are thought to have been described but have yet to reach the central databases).

To now, the best approximation of Earth's species total was based on the educated guesses and opinions of experts, who variously pegged the figure in a range from 3 to 100 million -- wildly differing numbers questioned because there is no way to validate them.

Drs. Mora and Worm, together with Dalhousie colleagues Derek P. Tittensor, Sina Adl and Alastair G.B. Simpson, refined the estimated species total to 8.7 million by identifying numerical patterns within the taxonomic classification system (which groups forms of life in a pyramid-like hierarchy, ranked upwards from species to genus, family, order, class, phylum, kingdom and domain).

Analyzing the taxonomic clustering of the 1.2 million species today in the Catalogue of Life and the World Register of Marine Species, the researchers discovered reliable numerical relationships between the more complete higher taxonomic levels and the species level.

Says Dr. Adl: "We discovered that, using numbers from the higher taxonomic groups, we can predict the number of species. The approach accurately predicted the number of species in several well-studied groups such as mammals, fishes and birds, providing confidence in the method."

When applied to all five known eukaryote* kingdoms of life on Earth, the approach predicted:

1. ~7.77 million species of animals (of which 953,434 have been described and cataloged)

2. ~298,000 species of plants (of which 215,644 have been described and cataloged)
3. ~611,000 species of fungi (moulds, mushrooms) (of which 43,271 have been described and cataloged)
4. ~36,400 species of protozoa (single-cell organisms with animal-like behavior, eg. movement, of which 8,118 have been described and cataloged)
5. ~27,500 species of chromista (including, eg. brown algae, diatoms, water moulds, of which 13,033 have been described and cataloged)

Total: 8.74 million eukaryote species on Earth.

(* Notes: Organisms in the eukaryote domain have cells containing complex structures enclosed within membranes. The study looked only at forms of life accorded, or potentially accorded, the status of "species" by scientists. Not included: certain micro-organisms and virus "types," for example, which could be highly numerous.)

Within the 8.74 million total is an estimated 2.2 million (plus or minus 180,000) marine species of all kinds, about 250,000 (11%) of which have been described and catalogued. When it formally concluded in October 2010, the Census of Marine Life offered a conservative estimate of 1 million+ species in the seas.

"Like astronomers, marine scientists are using sophisticated new tools and techniques to peer into places never seen before," says Australian Ian Poiner, Chair of the Census' Scientific Steering Committee. "During the 10-year Census, hundreds of marine explorers had the unique human experience and privilege of encountering and naming animals new to science. We may clearly enjoy the Age of Discovery for many years to come."

"The immense effort entering all known species in taxonomic databases such as the Catalogue of Life and the World Register of Marine Species makes our analysis possible," says co-author Derek Tittensor, who also works with Microsoft Research and the UN Environment Programme's World Conservation Monitoring Centre. "As these databases grow and improve, our method can be refined and updated to provide an even more precise estimate."

"We have only begun to uncover the tremendous variety of life around us," says co-author Alastair Simpson. "The richest environments for prospecting new species are thought to be coral reefs, seafloor mud and moist tropical soils. But smaller life forms are not well known anywhere. Some unknown species are living in our own backyards -- literally."

"Awaiting our discovery are a half million fungi and moulds whose relatives gave humanity bread and cheese," says Jesse Ausubel, Vice-President of the Alfred P. Sloan Foundation and co-founder of the Census of Marine Life. "For species discovery, the 21st century may be a fungal century!"

Mr. Ausubel notes the enigma of why so much diversity exists, saying the answer may lie in the notions that nature fills every niche, and that rare species are poised to benefit from a change of conditions.

In his analysis, Lord May says the practical benefits of taxonomic discovery are many, citing the development in the 1970s of a new strain of rice based on a cross between conventional species and one discovered in the wild. The result: 30% more grain yield, followed by efforts ever since to protect all wild varieties of rice, "which obviously can only be done if we have the appropriate taxonomic knowledge."

"Given the looming problems of feeding a still-growing world population, the potential benefits of ramping up such exploration are clear."

Based on current costs and requirements, the study suggests that describing all remaining species using traditional approaches could require up to 1,200 years of work by more than 300,000 taxonomists at an approximate cost of $US 364 billion. Fortunately, new techniques such as DNA barcoding are radically reducing the cost and time involved in new species identification.

Concludes Dr. Mora: "With the clock of extinction now ticking faster for many species, I believe speeding the inventory of Earth's species merits high scientific and societal priority. Renewed interest in further exploration and taxonomy could allow us to fully answer this most basic question: What lives on Earth?"

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by Census of Marine Life.

Journal Reference:

1. Camilo Mora, Derek P. Tittensor, Sina Adl, Alastair G. B. Simpson, Boris Worm. How Many Species Are There on Earth and in the Ocean? *PLoS Biology*, 2011; 9 (8): e1001127 DOI: 10.1371/journal.pbio.1001127

http://www.sciencedaily.com/releases/2011/08/110823180459.htm

Academic publishers make Murdoch look like a socialist

Academic publishers charge vast fees to access research paid for by us. Down with the knowledge monopoly racketeers

- George Monbiot
- guardian.co.uk, Monday 29 August 2011 21.08 BST

'Though academic libraries have been frantically cutting subscriptions to make ends meet, journals now consume 65% of their budgets.' Photograph: Peter M Fisher/Corbis

Who are the most ruthless capitalists in the western world? Whose monopolistic practices make Walmart look like a corner shop and Rupert Murdoch a socialist? You won't guess the answer in a month of Sundays. While there are plenty of candidates, my vote goes not to the banks, the oil companies or the health insurers, but – wait for it – to academic publishers. Theirs might sound like a fusty and insignificant sector. It is anything but. Of all corporate scams, the racket they run is most urgently in need of referral to the competition authorities.

Everyone claims to agree that people should be encouraged to understand science and other academic research. Without current knowledge, we cannot make coherent democratic decisions. But the publishers have slapped a padlock and a "keep out" sign on the gates.

You might resent Murdoch's paywall policy, in which he charges £1 for 24 hours of access to the Times and Sunday Times. But at least in that period you can read and download as many articles as you like. Reading a single article published by one of Elsevier's journals will cost you $31.50. Springer charges €34.95, Wiley-Blackwell, $42. Read 10 and you pay 10 times. And the journals retain perpetual copyright. You want to read a letter printed in 1981? That'll be $31.50.

Illustration by Daniel Pudles

Of course, you could go into the library (if it still exists). But they too have been hit by cosmic fees. The average cost of an annual subscription to a chemistry journal is $3,792. Some journals cost $10,000 a year or more to stock. The most expensive I've seen, Elsevier's Biochimica et Biophysica Acta, is $20,930. Though academic libraries have been frantically cutting subscriptions to make ends meet, journals now consume 65% of their budgets, which means they have had to reduce the number of books they buy. Journal fees account for a significant component of universities' costs, which are being passed to their students.

Murdoch pays his journalists and editors, and his companies generate much of the content they use. But the academic publishers get their articles, their peer reviewing (vetting by other researchers) and even much of their editing for free. The material they publish was commissioned and funded not by them but by us, through government research grants and academic stipends. But to see it, we must pay again, and through the nose.

The returns are astronomical: in the past financial year, for example, Elsevier's operating profit margin was 36% (£724m on revenues of £2bn). They result from a stranglehold on the market. Elsevier, Springer and Wiley, who have bought up many of their competitors, now publish 42% of journal articles.

More importantly, universities are locked into buying their products. Academic papers are published in only one place, and they have to be read by researchers trying to keep up with their subject. Demand is inelastic and competition non-existent, because different journals can't publish the same material. In many cases the publishers oblige the libraries to buy a large package of journals, whether or not they want them all. Perhaps it's not surprising that one of the biggest crooks ever to have preyed upon the people of this country – Robert Maxwell – made much of his money through academic publishing.

The publishers claim that they have to charge these fees as a result of the costs of production and distribution, and that they add value (in Springer's words) because they "develop journal brands and maintain and improve the digital infrastructure which has revolutionised scientific communication in the past 15 years". But an analysis by Deutsche Bank reaches different conclusions. "We believe the publisher adds relatively little value to the publishing process … if the process really were as complex, costly and value-added as the

publishers protest that it is, 40% margins wouldn't be available." Far from assisting the dissemination of research, the big publishers impede it, as their long turnaround times can delay the release of findings by a year or more.

What we see here is pure rentier capitalism: monopolising a public resource then charging exorbitant fees to use it. Another term for it is economic parasitism. To obtain the knowledge for which we have already paid, we must surrender our feu to the lairds of learning.

It's bad enough for academics, it's worse for the laity. I refer readers to peer-reviewed papers, on the principle that claims should be followed to their sources. The readers tell me that they can't afford to judge for themselves whether or not I have represented the research fairly. Independent researchers who try to inform themselves about important scientific issues have to fork out thousands. This is a tax on education, a stifling of the public mind. It appears to contravene the universal declaration of human rights, which says that "everyone has the right freely to … share in scientific advancement and its benefits".

Open-access publishing, despite its promise, and some excellent resources such as the Public Library of Science and the physics database arxiv.org, has failed to displace the monopolists. In 1998 the Economist, surveying the opportunities offered by electronic publishing, predicted that "the days of 40% profit margins may soon be as dead as Robert Maxwell". But in 2010 Elsevier's operating profit margins were the same (36%) as they were in 1998.

The reason is that the big publishers have rounded up the journals with the highest academic impact factors, in which publication is essential for researchers trying to secure grants and advance their careers. You can start reading open-access journals, but you can't stop reading the closed ones.

Government bodies, with a few exceptions, have failed to confront them. The National Institutes of Health in the US oblige anyone taking their grants to put their papers in an open-access archive. But Research Councils UK, whose statement on public access is a masterpiece of meaningless waffle, relies on "the assumption that publishers will maintain the spirit of their current policies". You bet they will.

In the short term, governments should refer the academic publishers to their competition watchdogs, and insist that all papers arising from publicly funded research are placed in a free public database. In the longer term, they should work with researchers to cut out the middleman altogether, creating – along the lines proposed by Björn Brembs of Berlin's Freie Universität – a single global archive of academic literature and data. Peer-review would be overseen by an independent body. It could be funded by the library budgets which are currently being diverted into the hands of privateers.

The knowledge monopoly is as unwarranted and anachronistic as the corn laws. Let's throw off these parasitic overlords and liberate the research that belongs to us.

• A fully referenced version of this article can be found on George Monbiot's website. On Twitter, @georgemonbiot

http://www.guardian.co.uk/commentisfree/2011/aug/29/academic-publishers-murdoch-socialist

Big City Dreams

September 1, 2011

It's not every day that the mayor of New York City asks universities if they want cheap land in one of the most expensive real estate markets in the country to develop a new campus.

So when Mayor Michael Bloomberg tested the waters with a statement this spring, institutions chomped at the bit. Since the city issued a formal request in July, several major research universities, both in the U.S. and abroad, have devoted significant resources to developing proposals for the chance to open a new campus focused on graduate degree programs and research in engineering, entrepreneurship, and technology transfer in the heart of New York City.

City officials -- particularly Bloomberg -- see the campus as a tool to spur job creation and economic development in an economic sector for which New York is not well known. University officials see the new campus as a rare opportunity to get their feet in the door of or expand their presence in a major metropolitan area that has become a magnet for top talent.

Beyond the immediate benefits to the university eventually selected and the city, the mayor's plan and the investment in university research by city hall are a statement of support for the idea that research universities can be economic drivers in local economies, an idea that many politicians and university officials cite but on which few act. "It's a vote of confidence in the health of the American research university and the capacity institutions have to make a significant economic impact," said Lisa Lapin, spokeswoman for Stanford University, one of the universities expected to submit a proposal.

Another New York Campus

New York City has no shortage of colleges and universities. With about 110 institutions serving more than 600,000 students, the city has one of the highest concentrations of students in the country.

What it doesn't have is a reputation as a destination for developing and attracting high tech industries. The city has several engineering schools, including Columbia's Fu Foundation School of Engineering and Applied Science and the Polytechnic Institute of New York University, though these schools tend not to top rankings. "During the 1980s and '90s, Silicon Valley – not New York – became the world capital of technology start-ups," Bloomberg said in a July speech announcing the request for proposals. "And that is still true today. But if I am right – and if we succeed in this mission – it won't be forever."

In talking about the initiative, Bloomberg has repeatedly said that New York needs to focus on developing companies and entrepreneurs involved in emerging sectors of the economy such as information technology. "Technology is critical to our growth -- and there is just not enough of it here," Bloomberg said in his July speech.

That is why the city is pursuing the new campus. Officials say they want a university with a track record of churning out patents and companies to develop a research and graduate education campus, particularly one focused on engineering, chemistry, physics, environmental science, and/or computer science. Officials said they are less interested in other sectors, such as biotechnology, because the city already has strong representation in those fields.

In exchange for investing in a campus in New York, officials said the city is willing to provide land in one of three sites -- Roosevelt Island, Governors Island, and the Brooklyn Navy Yard -- and up to $100 million in infrastructure improvements. Several officials at universities interested in the city's proposal say the combination of land and investment makes the competition a "once in a lifetime" opportunity.

The New York City Economic Development Corporation, a nonprofit organization overseen by city hall that works on metropolitan improvement initiatives, is overseeing the selection of the partner. The corporation has recruited an advisory panel to consult on the selection of which institution to pair with, and the final decision rests with the Bloomberg administration.

The development corporation's goal, said Seth W. Pinsky, its president, is to grow the chunk of New York's economy generated through technology to a level that it is commensurate with the overall economy.

Who's Biting?

When the development corporation put out its first request for expressions of interest last winter, 27 universities threw their hats in the ring either individually or as part of a consortium. That list included several universities based in New York, including Columbia University and New York University; several prominent U.S. universities, including Stanford University, Cornell University, and the University of Chicago; and several foreign institutions, including Technion – Israel Institute of Technology and the Korea Advanced Institute of Science and Technology.

In July, the city made a request for proposals from the 27 universities that expressed interest in the first round, as well as any university that met a set of criteria that included high rankings in engineering programs, an endowment of at least $1 billion, and a track record of spending a minimum of $75 million dollars annually on research in fields related to the proposed program. On the same day, both Cornell and Stanford announced that they would pursue the campus.

Since announcing their interest, Cornell and Stanford have been the most public about their intended plans if they secure the site and the city's value as a strategic location for expansion.

Administrators at Stanford said the city's request for an institution with a strong focus in technology and a history of developing companies is right up their alley. The university is credited with the development of Silicon Valley -- the only area of the country that receives more venture capital for technology start-ups than New York City -- and has a history of churning out companies based on student and faculty research, such as Hewlett-Packard, Google, Sun Microsystems, and others.

"This plays exactly to our strength as an entrepreneurial university with a culture of innovation and strength in applied sciences and engineering," Lapin said. "We can bring the expertise that they're seeking."

Stanford's vision is to develop the property on Roosevelt Island into a campus of about 100 faculty members and 2,200 graduate students. The initial campus would focus on information technology, entrepreneurship education and research, and executive education in technical fields.

If Stanford were to secure the spot, it would be opening its first full-fledged campus outside of Palo Alto. "While we are engaged as consultants and partners with a number of institutions around the world, we have so far chosen not set up another full-fledged campus primarily because we were concerned that we could not establish a permanent presence with a cohort of faculty and students whose quality matched that of our own campus," said Stanford University President John Hennessy in his annual university address in April. "But New York is different. We can attract great faculty and great students committed to Stanford to a New York campus."

Cornell administrators also envision a full-fledged campus on Roosevelt Island with programs in areas similar to those proposed by Stanford, though they hope to develop their research endeavors in hubs that focus on particular topics, such as mobile and social computing. These hubs would pull faculty from traditional departments, but unlike traditional departments, they would have a lifespan of decades rather than centuries.

The university already has an established presence in New York City, which is home to the university's medical center, and Dan Huttenlocher, dean of the faculty of computing and information science, said administrators view expansion into New York City as an important component of Cornell's strategy moving forward. "What the city's offering is a site to build a campus and the chance to accelerate in a strategic direction that we were already heading [in]," he said.

While Cornell and Stanford have been the most public about their plans for the New York City campus, other institutions say they are still considering the idea.

A spokesman for New York University said the institution will submit a proposal as part of a consortium that includes several universities and a corporate partner. Their plan focuses on developing a center that focuses on urban science and ideas to improve city life. While different in nature than the programs proposed by Cornell and Stanford, administrators said the center will stress the commercialization of research while furthering the universities' research strengths.

A spokesman for Columbia said the university is planning to respond to the city's request, but would not elaborate on the details. "Our response to the city's [request for proposals] will focus on opportunities that are consistent with our commitment to long-term academic and economic growth in Upper Manhattan," said Robert Hornsby, assistant vice president for media relations, in an e-mail.

A spokesman for the University of Chicago, which submitted a statement of interest during the first round, said the university was not planning to submit a proposal.

'A Significant Investment'

Universities pursuing the campus must put together a weighty proposal before the Oct. 28 deadline. Administrators from Stanford and Cornell said they have devoted personnel time to the project, brought in outside help to review legal issues and help them understand the development market in New York, and begun crafting responses to the city that will likely total hundreds of pages. Neither university was willing to say how much the development of its proposal will cost.

A spokeswoman for Cornell said administrators have regularly traveled between the university's main campus in Ithaca and the city to work on the proposal. Lapin from Stanford visited Roosevelt Island this week.

The institution that secures the city's blessing will likely have to make a substantial investment to get the campus off the ground. Unlike many branch campuses abroad, where foreign governments have picked up the tab for infrastructure and construction, the city views its investment as seed money, and does not want to underwrite the campus. "We have been clear that that is not our intention," Pinsky said. "The less they ask of us, the more attractive their proposals will be. That being said, we are willing to make an investment if it will show returns."

The city is asking for a first phase of at least 250,000 square feet and a final build out of a million square feet, which could easily end up costing the university billions of dollars.

But the large investments made by Stanford, Cornell, and other institutions competing for the city's space and resources indicate that officials think there is a significant advantage to being in New York City. Administrators cited the attractiveness of the city to students and faculty, the international connections available to institutions in the city, and the substantial business and cultural resources located there.

The city's economic impact study predicted that in the first 30 years, the campus would generate about 400 companies and create more than 7,000 construction jobs and more than 22,000 permanent jobs. Those jobs will likely increase the city's tax revenue by hundreds of millions of dollars, as well as support the local economy. "But most importantly," Bloomberg said, "the new campus will help us build a critical mass toward our ultimate goal: reclaiming our title as the world capital of technological innovation."

— **Kevin Kiley**

http://www.insidehighered.com/news/2011/09/01/competition_for_tech_campus_shows_strategic_importance_of_new_york_city

New Treatments for Baldness? Scientists Find Stem Cells That Tell Hair It's Time to Grow

Researchers have discovered the source of signals that trigger hair growth, an insight that may lead to new treatments for baldness. (Credit: © Tasosk / Fotolia)

ScienceDaily (Sep. 2, 2011) — Yale researchers have discovered the source of signals that trigger hair growth, an insight that may lead to new treatments for baldness.

The researchers identified stem cells within the skin's fatty layer and showed that molecular signals from these cells were necessary to spur hair growth in mice, according to research published in the Sept. 2 issue of the journal *Cell*.

"If we can get these fat cells in the skin to talk to the dormant stem cells at the base of hair follicles, we might be able to get hair to grow again," said Valerie Horsley, assistant professor of molecular, cellular and developmental biology and senior author of the paper.

Men with male pattern baldness still have stem cells in follicle roots but these stem cells lose the ability to jump-start hair regeneration. Scientists have known that these follicle stem cells need signals from within the skin to grow hair, but the source of those signals has been unclear.

Horsley's team observed that when hair dies, the layer of fat in the scalp that comprises most of the skin's thickness shrinks. When hair growth begins, the fat layer expands in a process called adipogenesis. Researchers found that a type of stem cell involved in creation of new fat cells -- adipose precursor cells -- was required for hair regeneration in mice. They also found these cells produce molecules called PDGF (platelet derived growth factors), which are necessary to produce hair growth.

Horsley's lab is trying to identify other signals produced by adipose precursor stem cells that may play a role in regulating hair growth. She also wants to know whether these same signals are required for human hair growth. Other authors from Yale are lead author Eric Festa, Jackie Fretz, Ryan Berry, Barbara Schmidt, Matthew Rodeheffer and Mark Horowitz.

The work was funded by the National Institutes of Health and the Connecticut Stem Cell Research Program.

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Yale University**.

Journal Reference:

1. Eric Festa, Jackie Fretz, Ryan Berry, Barbara Schmidt, Matthew Rodeheffer, Mark Horowitz, Valerie Horsley. **Adipocyte Lineage Cells Contribute to the Skin Stem Cell Niche to Drive Hair Cycling**. *Cell*, 2011; 146 (5): 761-771 DOI: 10.1016/j.cell.2011.07.019

http://www.sciencedaily.com/releases/2011/09/110901134641.htm

'XXX' Marks the Spot

September 2, 2011

The exercise of figuring out one's "porn star name" is probably more familiar to college students than to college administrators. (For the uninitiated: the standard formula is your first pet's name, then the name of the street you grew up on.) But a new standard for the addresses of pornographic Web domains, approved in March by the Internet Corporation for Assigned Names and Numbers (ICANN), might prompt administrators to think of their college's "porn star name," and consider whether they ought to snatch it up before some opportunistic flesh-peddler tries to do so.

College marketers may also have to decide if it is worth it to move beyond their traditional ".edu" domains to more intuitive Web addresses that will soon be available due to another change to the ICANN system — a question that touches on whether Web URLs are still relevant to institutional branding.

The ICM Registry, the official registrar for the new ".xxx" domains, will begin taking applications this month from trademark holders — including colleges — that do not wish to see their good names co-opted by an adult website. "The University of BigState may prefer that there not be a BigState.xxx domain," explained Gregory Jackson, the vice president for policy and analysis at Educause, in a memo on the organization's website.

Between Sept. 7 and Oct. 28, the ICM Registry will allow each non-porn institution that has trademarked its institution's name (and variations thereon) to preempt X-rated interlopers by blocking them from registering its trademarks as ".xxx" domains. For example, Harvard -- which owns a trademark on its name (as well as several variations, including "Hahvahd") -- will be able to register Harvard.xxx before anyone else has a chance to do so.

However, colleges that do not own trademarks on their names -- including colleges that cannot do so because their names are too generic, such as Smith College or Brown University -- will not be able to block adult entertainers from scooping up Smith.xxx and Brown.xxx when the ICM Registry begins processing registrations from non-trademark holding applicants from the porn industry on Nov. 8. (Brown will have the chance to block BrownUniversity.xxx, however, as it does own that trademark; Smith will not be able to block SmithCollege.xxx, as its trademark on those words expired in 1991.)

They will still be able to block those domains, however, if no industry entities have registered those sites by Dec. 6, when ICM will begin taking registrations from all applicants. That is also when colleges will be able to block variations on their names that might in fact be more appealing to pornographers seeking to capitalize on a college's brand, such as HotSmithWomen.xxx. (Such precautions are common in the corporate world, where companies such as Xerox have forfended against having their brands hijacked by online haters by registering domains like ihatexerox.net and xeroxcorporationsucks.com.) Any porn companies that want those domains will have first crack in November, if the trademarks on those exact phrases remain unclaimed.

The cost of blocking a ".xxx" domain is $200 or $300.

This might be much ado about nothing. A cursory scan of DomainRegistry.com suggests that porn-themed URLs that use the names of highly recognizable colleges are not exactly hot property. Searches of DomainRegistry.com for each of the Ivy League universities, appended with words such as "sluts" and "hotties" (e.g. www.harvardhotties.com), turned up only two registered domains — neither of which was being used for pornography.

"It's not clear to me that anybody should be worried," said Jackson, the policy analyst who penned the Educause memo, in an interview.

The bigger question colleges will have to face, Jackson says, is deciding whether they want to avail themselves of a new option of purchasing a domain whose address has a more intuitive suffix. ICANN will soon begin allowing institutions to purchase URLs that end in a specific name or phrase, rather than ".edu." For example, the admissions department at Carleton College could move from "carleton.edu/admissions" to "admissions.carleton," without any ".edu."

Unlike with the new ".xxx" registrations, trademark holders will not get first dibs on so-called "generic top-level domains" (gTLD), nor will institutions be permitted to reserve to prevent others from doing so when registration opens on January 12, 2012.

"My sense that the people who have talked about this, by and large, have been doing it from a marketing perspective," said Jackson. "What they want to do is get the name out in cleaner fashion."

But a "cleaner" URL comes at a cost. In order to own the ".carleton" domain, the college would have to pay ICANN $185,000 upfront and $25,000 per year after that. The institutional website is widely considered a crucial marketing tool for colleges, but at a time when visitors land in college-affiliated Web domains via Google searches, apps, or browser tabs, the relevance of the URL might be diminishing.

Jackson points to the rise of link-shorteners, which convert URLs to strings of gibberish economical enough to fit in a tweet, as evidence that the content of Web addresses has become less important. In light of that shift, Jackson says he doubts that many institutions will be willing to bear the cost of buying, maintaining and administrating a branded gTLD.

"We're already well on the way toward people not noticing what the actual URL is," he says.

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— **Steve Kolowich**

http://www.insidehighered.com/news/2011/09/02/colleges_might_have_to_block_pornographers_from_registering_domains_under_new_icann_web_address_rules

Up from the Depths: How Bacteria Capture Carbon in the 'Twilight Zone'

Bigelow's Dashiell Masland working with a Tecan Freedom EVO robotic liquid handler. (Credit: Dennis Griggs, Bigelow Laboratory Single Cell Genomics Center)

ScienceDaily (Sep. 1, 2011) — Understanding the flow and processing of carbon in the world's oceans, which cover 70 percent of Earth's surface, is central to understanding global climate cycles, with many questions remaining unanswered. Between 200 and 1,000 meters below the ocean surface exists a "twilight zone" where insufficient sunlight penetrates for microorganisms to perform photosynthesis. Despite this, it is known that microbes resident at these depths capture carbon dioxide that they then use to form cellular structures and carry out necessary metabolic reactions so that they can survive and reproduce.

Details are now emerging about a microbial metabolic pathway that helps solve the mystery of how certain bacteria do this in the dark ocean. These research results, which are enabling a better understanding of what happens to the carbon that is fixed in the oceans every year, were published by a team of researchers, including those from the U.S. Department of Energy (DOE) Joint Genome Institute (JGI), in the Sept. 2, 2011 edition of *Science*.

Carbon fixation in the dark ocean has so far been attributed primarily to the Archaea, single-celled organisms that often live in extreme environmental conditions. In this region of the ocean, the bacteria living there were thought to rely on organic compounds for both energy and carbon. According to DOE JGI collaborator Ramunas Stepanauskas, Director of the Bigelow Laboratory Single Cell Genomics Center and senior author of the *Science* paper, "Previous oceanographic models suggested that Archaea do not adequately account for the amount of carbon that is being fixed in the dark ocean. Our study discovered specific types of Bacteria rather than Archaea, and their likely energy sources that may be responsible for this major, unaccounted component of the dark ocean carbon cycle."

To overcome the challenge that had hindered studies of deep ocean microbes, which have not yet been cultivated in the laboratory, researchers employed innovative single-cell genomics techniques, where DOE JGI's Tanja Woyke and Alexander Sczyrba, Bigelow Laboratory's Ramunas Stepanauskas and their teams are among the pioneers. Study co-author Woyke explained, "After we sequenced the genomes of single cells that were isolated by our colleagues at Bigelow, it was possible to verify the predominant bacterial lineages capable of trapping carbon in this deep underwater region. "This study represents a pristine example for the use of single cell genome sequencing to decipher the metabolic capabilities of uncultured natural microbial consortia, providing a powerful complement to metagenomics."

Stepanauskas attributed the success of the project to the combined efforts of the DOE JGI, the Bigelow Laboratory, the Monterey Bay Aquarium Research Institute, the University of Vienna, and MIT. "This is the first application of a single-cell genomic approach to the deep ocean, one of the largest and least known biomes on the planet," emphasized David Kirchman, Harrington Professor of Marine Biosciences at the University of Delaware. "The paper radically changes our view about how microbes gain energy and flourish in the oceans."

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **DOE/Joint Genome Institute**.

Journal Reference:

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http://www.sciencedaily.com/releases/2011/09/110901142054.htm

Chasing Higher One

September 2, 2011

For several years, Higher One dominated the market for colleges and universities issuing student loan refunds by debit card. Their cards, often branded with the university's logo and sometimes doubling as student IDs, became the currency of choice at community colleges and many small state institutions, and the company maintained big profit margins -- despite complaints from students and advocates about some of its business practices.

Now it has new competition. Banks, former student loan originators and credit card companies have entered the market, offering prepaid debit cards and (in some cases) checking accounts where students can store refunds from student loans and Pell Grants. Many of the competitors are undercutting Higher One's more controversial fees and charges, which attracted protests as the company gained prominence.

The newcomers, which include Sallie Mae, Nelnet and Blackboard, are drawn in by a multitude of factors: the need to find new areas of business after the end of bank-based student lending, the income from interchange fees that merchants pay when students use debit cards for payment, or simply the desire for a piece of the growing pie of student loans and grants. But just how much they will influence the market remains to be seen.

"There certainly is an opportunity to grow," said Michael Taiano, a managing director in the research department at Sandler O'Neill & Partners, who tracks the stocks of both Higher One and Sallie Mae. But he said he doubts many institutions will break away from Higher One to join with a competitor, even if the fees for students are lower. "Schools are struggling with their budgets, looking for ways to become more efficient and cut costs, and this is probably one way that they can do it. I think there's opportunity there, but I don't know that the market is as big as it appears."

Financial aid reimbursements are issued when the total of a student's grants or loans paid to an institution exceeds the cost of tuition and fees. The remainder, which many students apply to textbooks, rent or other associated costs of living, traditionally was issued by paper check.

Debit cards, including those offered by Higher One, offered institutions several advantages: they required less staff time than processing paper refund checks, essentially outsourcing part of the functions of the bursar's or financial aid offices. They cost relatively little for colleges and universities; many of the fees are paid by students who use the service. Proponents say they save money for colleges and are safer for students without bank accounts, who otherwise might be paying check-cashing fees and carrying large sums of money, and more convenient for students who are used to relying on plastic.

Higher One's detractors cite fees they say are exorbitant: a 50-cent charge for using the card for a transaction with a personal identification number, as well as ATM charges (Higher One ATMs are located almost exclusively on campuses) and a fee of up to $19 for inactive accounts. Although students were not forced to accept the debit card, critics said institutions offered students little choice, in some cases requiring students to go through Higher One to receive the refund as a direct deposit.

The new options in the debit card market include a checking account by Sallie Mae and prepaid debit cards from Nelnet (in partnership with Citibank), PNC and Blackboard, the educational technology company. Most are relative newcomers -- although Sallie Mae previously offered a prepaid debit card, the majority of banks introduced their programs in the past 18 months. So far, few have gained traction or are willing to publicly say how many schools are affiliates. Some appear to have only one or two associated institutions; Sallie Mae, which appears to have the most, still has fewer than 50, Taiano said.

Many of the newcomers undercut Higher One on a contentious point: the 50-cent fee the company charged students who swiped their debit card and paid with a PIN, rather than a signature. Some also offer more free ATM transactions through national networks, or a monthly maintenance fee for inactive accounts lower than the fee Higher One charges.

Sallie Mae's No Fee Student Checking, structured as a checking account that includes a debit card rather than a prepaid card, has no fee for PIN transactions or ATM withdrawals within the Allpoint network. PNC Bank, which offers a prepaid Visa debit card, includes free withdrawals only at PNC ATMs. Blackboard in March 2010 introduced Blackboard Pay, a prepaid debit card with free ATM withdrawals at Allpoint networks and no PIN transaction fees. Three colleges began using the system in August.

"I think it's a very significant difference from the students' perspective," Mark Kantrowitz, publisher of Finaid.org, said of the lower fees. But whether that factor makes a difference for colleges is unclear, he added: institutions opt to use an outside vendor (rather than issuing their own checks or direct deposits) to save money for themselves, even if some costs are eventually passed along to students. So far, the new services have not promoted themselves as cheaper options for the colleges themselves. "What you essentially have here is a trade-off between the institution's pecuniary interest and the best interest of the student."

A New Direction

When bank-based student lending ended, Sallie Mae and Nelnet had to reinvent themselves to make up for the business lost in loan origination. The companies, already used to transferring funds, managing loans and maintaining student records, are seeking to expand the services they provide to financial aid officers, including billing and tuition payment plans as well as the refund cards.

"We are in the consumer banking business now," said Kelly Christiano, vice president of savings and rewards with Sallie Mae.

The amount of federal financial aid distributed has also increased during the recession, leading to a larger market of recipients. An institution facing budget cuts might be more likely to consider outsourcing some services, including refund disbursement, from its financial aid office to a third-party company. And when Higher One made an initial public offering in 2010, other companies saw the profits that could be made, Taiano said. The company reported $35.1 million in revenue in the second quarter of 2011.

Sallie Mae and Blackboard are pitching their lower fees as an advantage over Higher One. "Charging students fees to get access to the refunds they're getting from the school does not fit with providing a responsible product," Christiano said. But all the companies still make money through interchange fees, which banks charge retailers who accept debit or credit cards, as well as fees for lost cards and other costs that students pay.

"It allows the banking industry to skim revenue off of financial aid disbursement," said Richard Hershman, director of government relations for the National Association of College Stores. "For every dollar that flows out in financial aid, if the student doesn't take it out as cash, the banks are able to collect anywhere from a percent to in some cases 2 percent in interchange fees and processing fees."

The new entrants to the market have their advantages: Blackboard, Nelnet and Sallie Mae already have business relationships with institutions that might be interested in transitioning to debit cards, and their diversified businesses mean that they can afford to charge lower fees to students than Higher One does. But Higher One is in a strong position: in addition to its presence on more than 700 campuses, it holds several patents that could make it difficult for other companies to offer a combined student ID and debit card, Kantrowitz said.

Challenges on all sides

"A year ago, our biggest competitor was 'do nothing,' " said Dean Hatton, the president and CEO of Higher One, during a recorded investment Web seminar in June. "The addition of more competition in the space has had a very interesting effect: it actually has raised awareness among schools that there are things that they can do to improve things in the business office." The competition could be beneficial to the company, he added, because it creates "more active buyers" in the market.

Still, Higher One faces challenges of its own. Several analysts raised concerns about a conflict of interest, in part because the customer -- the college -- pays relatively little compared to the students, who bear the brunt of fees and charges. The company's banking partner, The Bancorp Bank, recently terminated its relationship with Higher One, despite the fact that Higher One deposits made up as much as 15 percent of its deposits, and estimated that the move would cost little, Taiano said. Since students withdraw the funds quickly, there's limited opportunity for the bank to invest the deposits and make a profit.Higher One has advertised that it is looking for a new banking partner and has changed such relationships in the past, Miles Lasater, the company's chief operating officer, said in an e-mailed statement. "In our history we've had partnerships with several banking institutions," Lasater said. "In past transitions there has been little change for students and administrations and we'll work towards that end in this transition, too."

The newer entrants also struggle with some of the same issues that drew scrutiny at Higher One: the bank still manages all of a university's financial aid reimbursement, and many of them push debit cards heavily. (While PNC notes that an electronic funds transfer to a checking account is faster than mailing a card, Nelnet presents a chart that makes the prepaid cards seem vastly superior on every front: they make funds available immediately, allow for one free foreign ATM withdrawal, offer "mobile messaging alerts," and are managed by a third party, which the company says promotes safety and security.)

Students still pay out-of-network ATM fees as well as other common charges. "All that money should be going to the educational purpose, which is the college costs," Kantrowitz said. "The purpose is not to enrich some bank somewhere that wants to earn."But perhaps the biggest challenge -- for both Higher One and its would-be competitors -- is how many more institutions they can attract. Though almost all institutions issue refunds, they are far more common at colleges where the average financial aid exceeds the cost of tuition, a market that includes more community colleges than expensive private colleges or public flagships.

While paper checks presented problems for colleges and students, including slow processing time, higher costs and risks for students without bank accounts, many colleges have used electronic transfers as the solution, said Anne Gross, vice president for regulatory affairs with the National Association of College and University Business Officers. In a recent NACUBO survey of 300 institutions, fewer than 5 percent were using preloaded debit cards to issue refunds, she said. Even at community colleges, which have been the most enthusiastic adopters, just over one-tenth relied on stored-value cards.

"Most schools would prefer that most students have bank accounts and checking accounts and kind of come into the mainstream" rather than rely on a pre-loaded debit card, Gross said. Many colleges also want to retain more control over reimbursements, whether to prevent fraud or to advise students on spending the money.

"You hear more about it, when it really isn't the biggest thing out there," Gross said of the stored-value cards. "I think it's likely to remain a niche product."

— **Libby A. Nelson**

http://www.insidehighered.com/news/2011/09/02/new_entrants_in_financial_aid_refund_business

Woolly Rhino Fossil Discovery in Tibet Provides Important Clues to Evolution of Ice Age Giants

Top: Woolly rhino skull and jaw. Bottom: Woolly rhino illustration by Julie Naylor. (Credit: Image courtesy of Natural History Museum of Los Angeles County)

ScienceDaily (Sep. 1, 2011) — A new paper published in the journal *Science* reveals the discovery of a primitive woolly rhino fossil in the Himalayas, which suggests some giant mammals first evolved in present-day Tibet before the beginning of the Ice Age. The extinction of Ice Age giants such as woolly mammoths and rhinos, giant sloths, and saber-tooth cats has been widely studied, but much less is known about where these giants came from, and how they acquired their adaptations for living in a cold environment.

A team of geologists and paleontologists led by Xiaoming Wang from the Natural History Museum of Los Angeles County (NHM) and Qiang Li of Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, uncovered a complete skull and lower jaw of a new species of woolly rhino (*Coelodonta thibetana*) in 2007, at the foothills of the Himalayas in southwestern Tibetan Plateau.

"Cold places, such as Tibet, Arctic, and Antarctic, are where the most unexpected discoveries will be made in the future -- these are the remaining frontiers that are still largely unexplored," said the NHM's Dr. Wang.

There are dual connections between the new paper and the Natural History Family of Museums (including the Natural History Museum and the Page Museum at the La Brea Tar Pits). Dr. Wang contributed to NHM's Age of Mammals exhibition, which depicts the creation of the Himalayan Mountains and Tibetan Plateau, and subsequent climactic changes of the Pleistocene Ice Age. Additionally, the largest Ice Age megafauna collection in the world is excavated, researched, and displayed at the Page Museum.

The new rhino is 3.6 million years old (middle Pliocene), much older and more primitive than its Ice Age (Pleistocene) descendants in the mammoth steppes across much of Europe and Asia. The extinct animal had developed special adaptations for sweeping snow using its flattened horn to reveal vegetation, a useful behavior for survival in the harsh Tibetan climate. These rhinos lived at a time when global climate was much warmer and the northern continents were free of the massive ice sheets seen in the Ice Age later.

The rhino accustomed itself to cold conditions in high elevations and became pre-adapted for the future Ice Age climate. When the Ice Age eventually arrived around 2.6 million years ago, the new paper posits, the cold-loving rhinos simply descended from the high mountains and began to expand throughout northern Asia and Europe.

In addition to the new woolly rhino, the paleontologist team also uncovered extinct species of three-toed horse (*Hipparion*), Tibetan bharal (*Pseudois*, also known as blue sheep), chiru (*Pantholops*, also known as Tibetan antelope), snow leopard (*Uncia*), badger (*Meles*), as well as 23 other kinds of mammals.

The team's new fossil assemblage from Tibet offers new insights into the origin of the cold-adapted Pleistocene megafauna, which has usually been sought either in the arctic tundra or in the cold steppes elsewhere. This new evidence offers an alternative scenario: the harsh winters of the rising Tibetan Plateau may have provided the initial step towards cold-adaptation for several subsequently successful members of the late Pleistocene mammoth fauna in Europe, Asia, and to a lesser extent, North America. The Tibetan Plateau may have been another cradle of the Ice Age giants.

"This discovery clarifies the origin of the woolly rhinoceros -- and perhaps much of the now extinct, cold-adapted, Pleistocene Eurasian megafauna -- as the high-altitude environments of the Zanda Basin of the primordial Pliocene Himalayas," said H. Richard Lane of the National Science Foundation (NSF)'s Division of Earth Sciences.

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Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Natural History Museum of Los Angeles County**, via EurekAlert!, a service of AAAS.

Journal Reference:

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http://www.sciencedaily.com/releases/2011/09/110901142100.htm

New Programs: Pharmacy, Justice, Accountancy

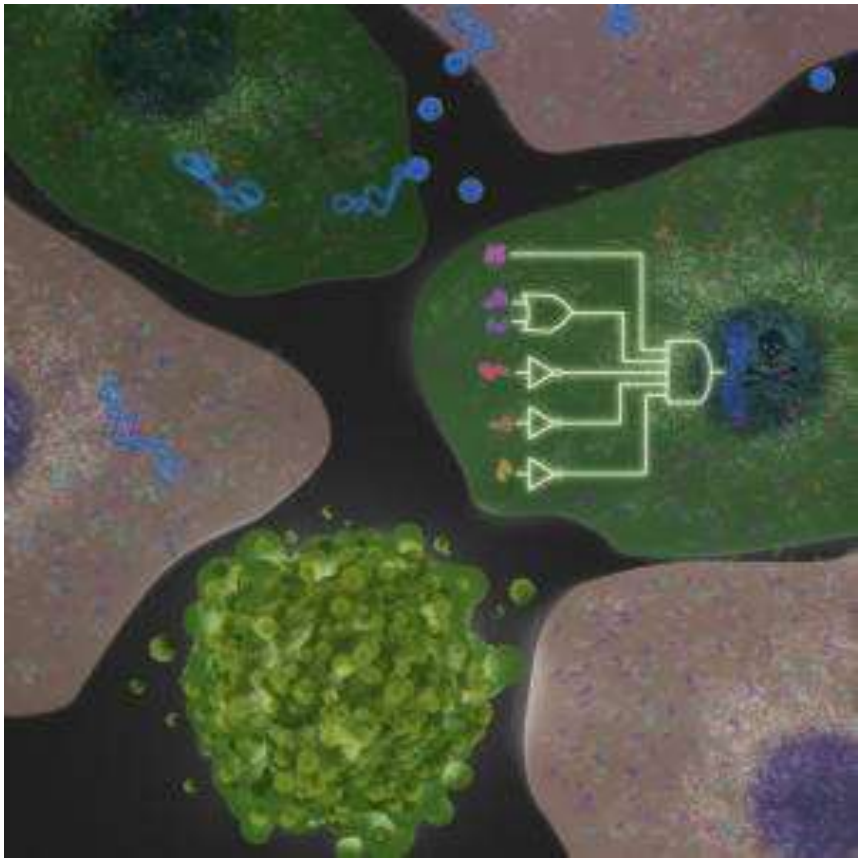
September 2, 2011

- Butler University is starting a doctor of pharmacy/master's in pharmaceutical sciences dual degree.
- Phoenix College, of the Maricopa Community College District, is starting an online associate in applied science degree in the administration of justice.
- Vanderbilt University is starting a master of accountancy program that focuses on preparing students for careers in valuation services for international public accounting firms.

— **Scott Jaschik**

http://www.insidehighered.com/news/2011/09/02/colleges_start_new_programs

Biological 'Computer' Destroys Cancer Cells: Diagnostic Network Incorporated Into Human Cells



The wiring diagram of the cellular computer: all five factors must be in their correct state in order to trigger cell death. (Credit: Illustration by Benenson Y. & R. Weiss)

ScienceDaily (Sep. 1, 2011) — Researchers led by ETH professor Yaakov Benenson and MIT professor Ron Weiss have successfully incorporated a diagnostic biological "computer" network in human cells. This network recognizes certain cancer cells using logic combinations of five cancer-specific molecular factors, triggering cancer cells destruction.

Yaakov (Kobi) Benenson, Professor of Synthetic Biology at ETH Zurich, has spent a large part of his career developing biological computers that operate in living cells. His goal is to construct biocomputers that detect molecules carrying important information about cell wellbeing and process this information to direct appropriate therapeutic response if the cell is found to be abnormal. Now, together with MIT professor Ron Weiss and a team of scientists including post-doctoral scholars Zhen Xie and Liliana Wroblewska, and a doctoral student Laura Prochazka, they made a major step towards reaching this goal.

In a study that has just been published in *Science*, they describe a multi-gene synthetic "circuit" whose task is to distinguish between cancer and healthy cells and subsequently target cancer cells for destruction. This circuit works by sampling and integrating five intracellular cancer-specific molecular factors and their concentration. The circuit makes a positive identification only when all factors are present in the cell, resulting in a highly precise cancer detection. Researchers hope that it can serve a basis for very specific anti-cancer treatments.

Selective destruction of cancer cells

The scientists tested the gene network in two types of cultured human cells: cervical cancer cells, called HeLa cells, and normal cells. When the genetic bio-computer was introduced into the different cell types, only HeLa cells, but not the healthy ones, were destroyed.

Extensive groundwork was required to achieve this result. Benenson and his team had to first find out which combinations of molecules are unique to HeLa cells. They looked among the molecules that belong to the class of compounds known as microRNA (miRNA) and identified one miRNA combination, or profile, that was typical of a HeLa cell but not any other healthy cell type.

Finding the profile was a challenging task. In the human body there are about 250 different healthy cell types. In addition, there are numerous variants of cancer cells, of which hundreds can be grown in the laboratory. Still greater is the diversity of miRNA: between 500 to 1000 different species have been described in human cells. "Each cell type, healthy or diseased, has different miRNA molecules switched on or off," says Benenson.

Five factors for cancer profile

Creating a miRNA "profile" is not unlike finding a set of symptoms to reliably diagnose a disease: "One symptom alone, such as fever, can never characterize a disease. The more information is available to a doctor, the more reliable becomes his diagnosis," explains the professor, who came to ETH from Harvard University a year and a half ago. The researchers have therefore sought after several factors that reliably distinguish HeLa cancer cells from all other healthy cells. It turned out that a combination of only five specific miRNAs, some present at high levels and some present at very low levels, is enough to identify a HeLa cell among all healthy cells.

A network operates similar to a computer

"The miRNA factors are subjected to Boolean calculations in the very cell in which they are detected. The biocomputer combines the factors using logic operations such as AND and NOT, and only generates the required outcome, namely cell death, when the entire calculation with all the factors results in a logical TRUE value," says Benenson. Indeed, the researchers were able to demonstrate that the network works very reliably in living cells, correctly combining all the intracellular factors and giving the right diagnosis. This, according to Benenson, represents a significant achievement in the field.

Animal Model and Gene Therapy

In a next step, the team wants to test this cellular computation in an appropriate animal model, with the aim to build diagnostic and therapeutic tools in the future. This may sound like science fiction, but Benenson believes that this is feasible. However, there are still difficult problems to solve, for example the delivery of foreign genes into a cell efficiently and safely. Such DNA delivery is currently quite challenging. In particular this approach requires temporary rather than permanent introduction of foreign genes into the cells, but the currently available methods, both viral and chemical, are not fully developed and need to be improved.

"We are still very far from a fully functional treatment method for humans. This work, however, is an important first step that demonstrates feasibility of such a selective diagnostic method at a single cell level," said Benenson.

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **ETH Zurich/Swiss Federal Institute of Technology**. The original article was written by Peter Rüegg.

Journal Reference:

1. Z. Xie, L. Wroblewska, L. Prochazka, R. Weiss, Y. Benenson. **Multi-Input RNAi-Based Logic Circuit for Identification of Specific Cancer Cells**. *Science*, 2011; 333 (6047): 1307 DOI: 10.1126/science.1205527

http://www.sciencedaily.com/releases/2011/09/110901142056.htm

Academically on Course

September 2, 2011
By **Linda M. Grasso**

Has public higher education outlived its usefulness -- like cassette tapes and typewriters? Are our students "academically adrift," our institutions shams? Who benefits from this tale? Policy-makers and government officials are regarding public higher education as an industry that needs to operate on cheap labor in order to manufacture products. William Deresiewicz, Peter Brooks and Martha Nussbaum make clear the consequences: the dismantling of public higher education eviscerates the creation and perpetuation of knowledge, access to education, and the principle that an educated citizenry is the keystone of democracy.

The crisis in higher education must be redefined by those of us in public institutions who are living it daily. For us, there are two crises: the bowdlerizing of what learning means, and the critical need for a counter-discourse that will lead to material change in public attitudes and allocation of resources.

Numbers reveal a certain kind of information and conceal other kinds, such as what it means to be a human being. How do we quantify students' experiencing the wonder of intellectual discovery, those moments when, as Rita Dove conveys so beautifully in her poem "Geometry," the ordinary is transformed into transcendent possibility? How is this learning accounted for when it occurs outside a public college course or institution, but is a direct result of both?

I prove a theorem and the house expands:
the windows jerk free to hover near the ceiling,
the ceiling floats away with a sigh.

As the walls clear themselves of everything
but transparency, the scent of carnations
leaves with them. I am out in the open

And above the windows have hinged into butterflies,
sunlight glinting where they've intersected.
They are going to some point true and unproven.

To those of us who teach working-class students that using their minds expands and transforms their lives, the data on spreadsheets is akin to thinking of students as if they were part numbers. In our classes, we propel students to grapple with the paradoxes of the "true and unproven" gleaned from different disciplinary perspectives. At semester's end, we judge how well they've achieved this and other objectives and assign a grade. We can never assess, however, if, when, or how students integrate what they've learned into their psyches and experiences. Counting, quantifying, and measuring are not the only ways to make sense of what and how students learn. These methods do not illuminate the value of a college education to working-class students for whom privilege is not a birthright.

Stories and story-telling are other options, potent sources of information. Stories provide entrée to the inner life, "ourself behind ourself concealed," access to knowledge about what it means to experience learning. Stories humanize numbers on spreadsheets. They are a different kind of currency in an economy in which the exchange of ideas is the basis of community. Stories perform a multiplicity of functions as Robert Coles reminds us: they "point us in new directions, or give us the courage to stay a given course. They can offer us kinsmen, kinswomen, comrades, advisers — offer us other eyes through which we might see, other ears with which we might make soundings." Stories, the ones we and our students tell, make possible an alternate way of thinking about learning, success, and achievement in publicly funded academic institutions.

Explaining Liberal Education
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Here is such a story. I was on a New York City subway deeply absorbed in reading Tim O'Brien's book *The Things They Carried* when a young man sitting across from me noticed the book's title and started talking to me: "I remember that story. That's the story that begins with the description of what the soldiers are carrying. Oh, I remember that story. We read it in my freshman English class."

O'Brien's book is indeed memorable. A searing account of soldiering in Vietnam, the collection of interwoven stories probes the anguish of war while meditating on the porous boundaries among reality, truth, and fiction. Most spectacularly, O'Brien employs the metaphor of carrying to convey the gravity of heartbreak, senseless loss, and war's breach of moral ethics. "First Lieutenant Jimmy Cross carried letters from a girl named Martha, a junior at Mount Sebastian College in New Jersey," the first story begins. "They were not love letters, but Lieutenant Cross was hoping, so he kept them folded in plastic at the bottom of his rucksack." Within the first two pages, O'Brien develops the metaphor further by listing the literal objects the soldiers wore on their bodies, hauled on their backs, and stashed in their pockets.

The subway encounter between the young man and me is as symbolic as the literal weight of the items the soldiers carried: the interaction encapsulates the very best a liberal arts general education can achieve. Something in the O'Brien text, the reading, the discussion, and the college classroom experience entered into the student, changed the way he constructed meaning, and became part of his world. Like the soldiers who carry the material and psychological weight of war, the student carries the book and the experience of reading it with him, and that is what inspired him to initiate connection with a stranger on a New York City subway.

The experience in the general education classroom provided the model for the interaction. The young man wanted to create connection about being moved emotionally, his discovery of the meaning of metaphor, and his memory of that experience. The interaction between the young man and me sparked by the O'Brien text suggests that the general education classroom fosters community building. Unknown to each other, the young man and I are part of a community premised on the idea that learning, and communing about learning, are fundamental, unifying values. Not limited by class or status, the community is the Jeffersonian ideal of an enlightened democratic citizenry. All involved, including the English professor who taught the class, the public institution in which the student took the class, and the faculty who designed the curriculum and deemed it a requirement, are academically on course, guided by a compass that keeps the true meaning of learning in view. Best explained by Ken Bain, true learning occurs when students embrace "new mental models of reality" spurred by teaching that cultivates their abilities to question, judge, evaluate, and construct meaning out of facts and information. True learning is personal and intellectual transformation.

In the story I just told, what proves the student's learning? The student may not have done well in his freshman English class. He might have failed the class, transferred to another college, or dropped out for a year or two. He could be a statistic on a retention or graduation rate chart. Outcomes, measures, deliverables: inadequate. What this student learned is ineffable, as difficult to wrap our minds around as Emily Dickinson's claim that the Brain is wider than the sky.

The Brain -- is wider than the Sky –

For – put them side by side –

The one the other will contain

With ease – and You – beside

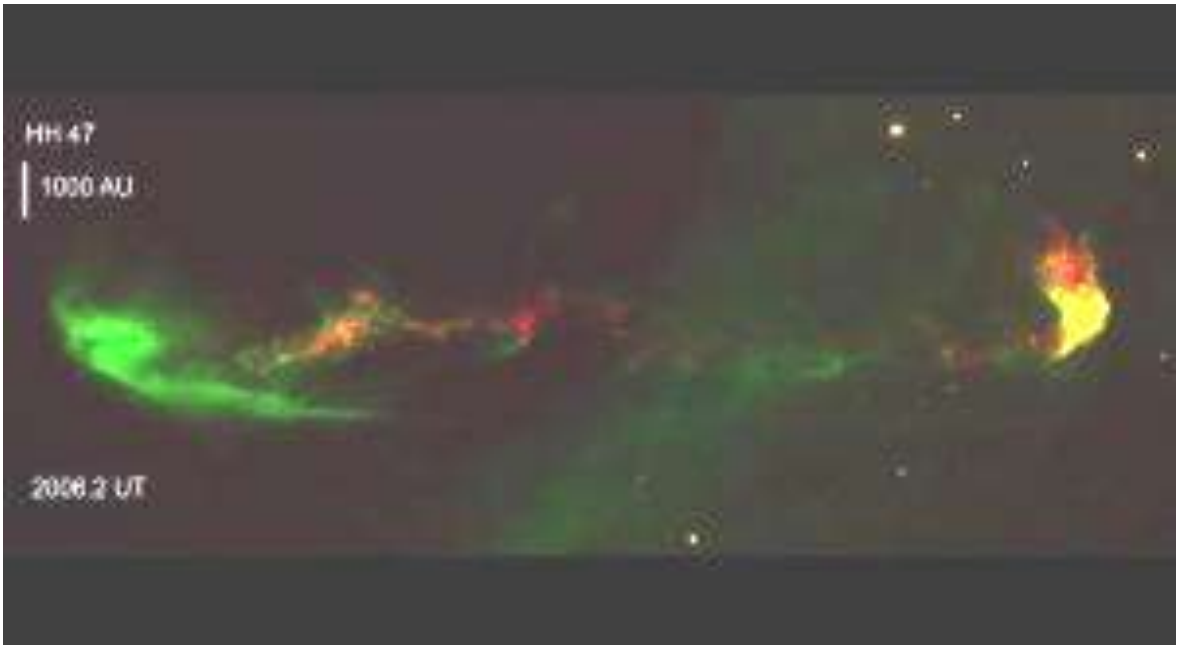
Dickinson's dictum about the sanctity of the human imagination must guide us as we create a counter-discourse about the crisis in public higher education. Colleges and universities are not factories in which we produce widgets on an assembly line. Academics work with people, human beings whose height and weight can be measured, yes, but whose brains are wider than the sky, "For — put them side by side — /The one the other will contain/ with ease — and You — beside--."

We need to create a competing conversation that honors the idea that brains are wider than the sky and deeper than the sea, "For — hold them — Blue to Blue — /The one the other will absorb — / As sponges — Buckets — do." And we need to tell a collective story about what is right and on course about public higher education: the ways in which it defies an intellectual caste system and is currently one of the few places that comes close to realizing the American value of equality — in the diversity of faculty and students, and the pursuit of unregulated intellectual freedom.

Linda M. Grasso is professor and chair of English at York College of the City University of New York.

http://www.insidehighered.com/views/2011/09/02/essay_argues_that_academe_is_not_adrift_but_needs_to_do_a_better_job_of_communicating

Hubble Movies Reveal Solar-System-Sized Traffic Jams: Giant Jets Spewing from Newborn Stars Revealed in Telescope's Images



Astronomers have created time-lapse movies that offer astronomers their first glimpse of the dynamic behavior of stellar jets, huge torrents of gas and particles that spew from the poles of newborn stars. (Credit: Image courtesy of Rice University)

ScienceDaily (Sep. 2, 2011) — When it comes to big-budget action movies, Rice University astronomer Patrick Hartigan prefers Hubble to Hollywood.

Using Hubble Space Telescope images collected over 14 years, Hartigan has created time-lapse movies that offer astronomers their first glimpse of the dynamic behavior of stellar jets, huge torrents of gas and particles that spew from the poles of newborn stars.

An analysis of the movies that was published in The Astrophysical Journal is forcing astronomers to rethink some of the processes that occur during the latter stages of star birth. And in an effort to learn even more, Hartigan and colleagues are using powerful lasers to recreate a small-scale version of the solar-system-sized jets in a lab in upstate New York.

"The Hubble's given us spectacular images," said Hartigan, professor of physics and astronomy at Rice. "In the nebulae where stars are born, for instance, we can see beautiful filaments and detailed structure. We know these images are frozen snapshots in time, but we would need to watch for hundreds of thousands of years to see how things actually play out."

Hartigan said stellar jets are different because they move very quickly. Stellar jets blast out into space from the poles of newly formed stars at about 600,000 miles an hour. Astronomers first noticed them about 50 years ago, and they believe the sun probably had stellar jets when it formed about 4.5 billion years ago.

Hartigan began using Hubble to collect still frames of stellar jets in 1994. The jets emerge from each pole of a young star, and Hartigan used Hubble to revisit the jets from three stars in 1994, 1998 and 2008. All three

stars are about 1,350 light years from Earth. Two are near the Orion Nebula, and the third is in the southern sky in the constellation Vela.

By lacing the images together and using a computer to fill in what occurred between still frames, Hartigan and his collaborators created time-lapse movies. The movies clearly showed something that wasn't obvious in any of the still images; clouds of dust and gas within the jets move at different speeds.

"The bulk motion of the jet is about 300 kilometers per second," Hartigan said. "That's really fast, but it's kind of like watching a stock car race; if all the cars are going the same speed, it's fairly boring. The interesting stuff happens when things are jumbling around, blowing past one another or slamming into slower moving parts and causing shockwaves."

Understanding what happens in those huge collisions is another challenge. The phenomena didn't look like anything that Hartigan and his astronomer colleagues had seen. But when he showed them to colleagues who were familiar with the physics of nuclear explosions, they immediately saw patterns in the shockwaves that looked familiar.

"The fluid dynamicists immediately picked up on an aspect of the physics that astronomers typically overlook, and that led to a different interpretation for some of the features we were seeing," Hartigan explained. "The scientists from each discipline bring their own unique perspectives to the project, and having that range of expertise has proved invaluable for learning about this critical phase of stellar evolution."

Motivated by the results from Hubble, Hartigan and colleagues are conducting experiments at the Omega Laser Facility in Rochester, New York, to recreate small-scale versions of the solar-system-sized features captured in the movies.

"It's one more tool we have to better understand the underlying physics," Hartigan said.

In addition to Hartigan, the research team includes Adam Frank of the University of Rochester; John Foster and Paula Rosen of the Atomic Weapons Establishment in Aldermaston, U.K.; Bernie Wilde, Rob Coker and Melissa Douglas of Los Alamos National Laboratory in New Mexico; and Brent Blue and Freddy Hansen of General Atomics in San Diego, Calif.

The research is funded by NASA and the National Nuclear Security Administration. A video illustrating the research is available at: http://www.youtube.com/watch?v=0Yf_O-S4FM8

Hartigan's Hubble Space Telescope movies are available at: http://sparky.rice.edu/~hartigan/movies.html

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Rice University**.

Journal Reference:

1. P. Hartigan, A. Frank, J. M. Foster, B. H. Wilde, M. Douglas, P. A. Rosen, R. F. Coker, B. E. Blue. **Fluid Dynamics of Stellar Jets in Real Time: Third Epoch HST Images of HH 1, HH 34, and HH 47**. *The Astrophysical Journal*, 2011; 736 (1): 29 DOI: 10.1088/0004-637X/736/1/29

http://www.sciencedaily.com/releases/2011/09/110901105419.htm

Education Is in the Streets

August 31, 2011
By **Scott McLemee**

When students took to the streets in Rome last November to demonstrate against proposed budget cuts to the university system, they introduced something new to the vocabulary of protest. To defend themselves from police truncheons they carried improvised shields made of polystyrene, painted, on the front, with the names of classic works of literature and philosophy: *Moby Dick, The Republic, Don Quixote, A Thousand Plateaus*…. The practice caught on. A couple of weeks later, another "Book Bloc" appeared in London as students and public-sector workers demonstrated against rising tuition.

By the time an enormous anti-Berlusconi protest took place in Rome on December 14, a group of Italian faculty members had decided on a syllabus of 20 titles worth carrying into battle. It's all over the place: *The Odyssey* and *Fahrenheit 451*, Spinoza's *Ethics* and Donna Haraway's *Cyborg Manifesto*, Foucault and *Fight Club*. And so when the forces of law and order descended on the protesters, swinging, it was a visual allegory of culture in the age of austerity -- budget-cutting raining blows on the life of the mind, though also, perhaps, the canon as defensive weapon.

The full list of works suggested by the wonderfully named Network of Rebel Faculty appears in *Springtime: The New Student Rebellions*, a collection of articles and images edited by Clare Solomon and Tania Palmieri; it was published by Verso in England earlier this year, and is appearing in the U.S. just now. Solomon was president of the student union at the University of London during the protests last year; the introduction, dated from January, has the feel of something written with the adrenaline and endorphins still flowing. Some of the pieces at the end of the book narrate and analyze the then-breaking developments in Tunisia, Egypt, and Algeria. In addition to sections on France and Greece, there are documents and analyses from the student protests in California during the 2009-1010 academic year.

The effect is less that of an anthology than of a scrapbook -- with articles, photographs, and street posters taped in alongside printouts of Twitter exchanges and (every so often) excerpts from accounts of student protests from the late 1960s that tend to be jarringly inapposite. "The tradition of all dead generations weighs like a nightmare on the brains of the living," as somebody once pointed out. "And just as they seem to be occupied with revolutionizing themselves and things, creating something that did not exist before, precisely in such epochs of revolutionary crisis they anxiously conjure up the spirits of the past to their service, borrowing from them names, battle slogans, and costumes in order to present this new scene in world history in time-

honored disguise and borrowed language." The relevance of the slogans of 1968 (with their assumptions about alienation amid growing affluence and free time) is now just about nil. Maybe we should forget them for a while. The student protests of the past two years have resembled wildcat strikes or factory occupations more than reenactments of the Free Speech Movement or Vietnam-era teach-ins.

That's no accident. The role of the economic crisis in precipitating university unrest -- whether through rising postsecondary fees, shrinking job markets, or the inability of sudden fragility of neoliberalized states (unable to preserve social order through coercion alone but unwilling to shore up social services by raising taxes) -- seems clear enough.

In an e-mail exchange with Solomon, I asked if the world situation since the financial heart attack of 2008 were creating a shared ideology or a set of demands among student protesters.

"The general demands of the youth and student movements, are not necessarily codified," she responded, "but they are quite clear. Firstly, there's a cry of anger. Society has prospered, but now asks them to pay for the crisis and so often ignores their voices. The increasing marketization and cost of education, lack of post-education jobs and opportunities, ever-increasing living and housing costs, are forcing young people onto the unemployment lines, keeping them living with their parents longer and with little disposable income to enjoy life. Parts of society and government continue to demonize and vilify young people as dangerous and 'other,' as almost outside of accepted society."

Part of the dissatisfaction -- at least as reflected in the sections of the book on European protests -- comes from the rise of "the enterprise university" as credentialing agency for a labor market that is constantly in flux. One chapter of *Springtime*, "The Factory of Precarious Workers" by Giulio Calella, says that recent reforms in Italy "would transform the university into a location for so-called permanent training" while "promoting competition among universities in order to put pressure on lecturers to increase productivity" and assessing every element of academic life as a "relationship between input and output" geared to maximum "customer satisfaction."

Here an American idiom occurs to the American reader: "Yeah, tell me about it." But Calella is anything but resigned to the situation he describes, and ardent in his protest at the narrowing of the pedagogical horizon:

"The slogan of the old university's professor, according to which anyone who entered the university was a 'scholar, not a student,' has been buried under the super-professional labels of the new laurea degree courses; the frantic pace imposed on full-time students; continuous assessments; bibliographies made of textbooks; and a de facto trimester system which impedes any attempt by the student to familiarize himself or herself with the subject, and therefore to develop any kind of critical approach to it. This is a deskilled and devalued pedagogy, the engine of a factory that produces precarious workers and fragments knowledge production by amplifying its specialized and partial character."

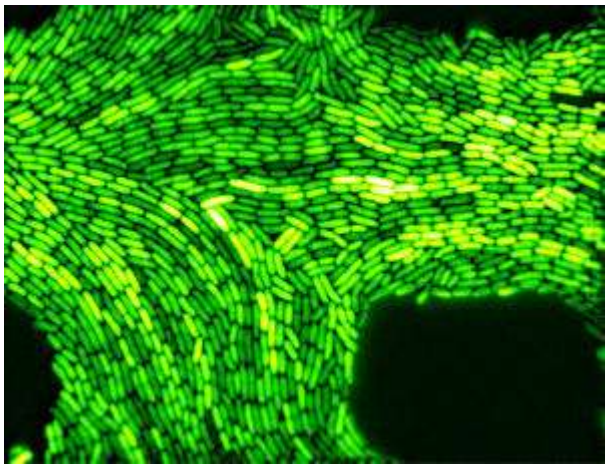
Clare Solomon registered much the same complaint in our exchange. "We want a new type of education," she wrote, "not just faceless, corporate entities pandering to the 'employability agenda' at the expense of real co-produced education. So this is more than just protest against rising fees."

It's tempting to quote a good deal more from *Springtime*, which will probably be a popular book among some layers of the student body over the next year. And the particular combination of issues it raises should earn it some attention from faculty as well. Despite the occasional nod to Boomer nostalgia (the lyrics to "Street Fighting Man" in Mick Jagger's handwriting, for example), the collection is really defined by a very contemporary overlap of problems: the economic pressures on all levels of education, on the one hand; and the difficulty of defining education's social value when the labor market can't absorb many new graduates, on the other. ("A university diploma is now worth no more than a share in General Motors," in the words of an acerbic pamphlet from the California protests.)

But as much as anything else, I hope that readers will focus on the pages devoted to the Book Bloc, which include photographs of its various incarnations at a number of protests. “Books are our tools,” reads a statement from Art Against Cuts, a British group; “we teach with them, we learn with them, we play with them, we create with them, we make love with them and, sometimes, we must fight with them.” There is a vitality to this formulation that is anything but bookish. It involves a sense of culture as an active process -- a verb you practice, rather than a noun you accumulate. And respect for one’s tools is, after all, the prerequisite for any education worthy of the name.

http://www.insidehighered.com/views/mclemee/mclemee_on_student_protest_book

Glowing, Blinking Bacteria Reveal How Cells Synchronize Biological Clocks



Green fluorescent protein causes the E. coli to glow when the cells' clock is activated. (Credit: UC San Diego)

ScienceDaily (Sep. 2, 2011) — Biologists have long known that organisms from bacteria to humans use the 24 hour cycle of light and darkness to set their biological clocks. But exactly how these clocks are synchronized at the molecular level to perform the interactions within a population of cells that depend on the precise timing of circadian rhythms is less well understood.

To better understand that process, biologists and bioengineers at UC San Diego created a model biological system consisting of glowing, blinking *E. coli* bacteria. This simple circadian system, the researchers report in the September 2 issue of *Science*, allowed them to study in detail how a population of cells synchronizes their biological clocks and enabled the researchers for the first time to describe this process mathematically.

"The cells in our bodies are entrained, or synchronized, by light and would drift out of phase if not for sunlight," said Jeff Hasty, a professor of biology and bioengineering at UC San Diego who headed the research team. "But understanding the phenomenon of entrainment has been difficult because it's difficult to make measurements. The dynamics of the process involve many components and it's tricky to precisely characterize how it works. Synthetic biology provides an excellent tool for reducing the complexity of such systems in order to quantitatively understand them from the ground up. It's reductionism at its finest."

To study the process of entrainment at the genetic level, Hasty and his team of researchers at UC San Diego's Biocircuits Institute combined techniques from synthetic biology, microfluidic technology and computational modeling to build a microfluidic chip with a series of chambers containing populations of E. coli bacteria. Within each bacterium, the genetic machinery responsible for the biological clock oscillations was tied to green fluorescent protein, which caused the bacteria to periodically fluoresce.

To simulate day and night cycles, the researchers modified the bacteria to glow and blink whenever arabinose -- a chemical that triggered the oscillatory clock mechanisms of the bacteria -- was flushed through the microfluidic chip. In this way, the scientists were able to simulate periodic day-night cycles over a period of only minutes instead of days to better understand how a population of cells synchronizes its biological clocks.

Hasty said a similar microfluidic system in principal could be constructed with mammalian cells to study how human cells synchronize with light and darkness. Such genetic model systems would have important future applications since scientists have discovered that problems with the biological clock can result in many common medical problems from diabetes to sleep disorders.

Other members of Hasty's team included Lev Tsimring, associate director of the BioCircuits Institute, and bioengineering graduate students Octavio Mondragon, Tal Danino and Jangir Selimkhanov. Their research was supported by grants from the National Institutes of Health and General Medicine and the San Diego Center for Systems Biology.

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of California - San Diego**.

Journal Reference:

1. Octavio Mondragón-Palomino, Tal Danino, Jangir Selimkhanov, Lev Tsimring, and Jeff Hasty. **Entrainment of a Population of Synthetic Genetic Oscillators**. *Science*, 2 September 2011: Vol. 333 no. 6047 pp. 1315-1319 DOI: 10.1126/science.1205369

http://www.sciencedaily.com/releases/2011/09/110901142104.htm

The Broccoli of Higher Ed

August 30, 2011
By **Daniel L. Everett**

We hear these days of the "crisis of the humanities." The number of majors, jobs, and student interest in these subjects is dropping. *The Boston Globe* offered one report on the worries of the humanities in an article last year about the new Mandell Center at Brandeis University. The *Globe* asserted, "At college campuses around the world, the humanities are hurting. Students are flocking to majors more closely linked to their career ambitions. Grant money and philanthropy are flowing to the sciences. And university presidents are worried about the future of subjects once at the heart of a liberal arts education."

Such gloom must be placed in context. Doubts about the humanities have been around at least since Aristophanes wrote *The Clouds*. The playwright claimed that if a man engaged in the "new" Socratic form of teaching and questioning, he could wind up with big genitals (apparently seen as a negative side effect) due to a loss of self-control. But the Socratic humanities survived, in spite of the execution of their founder, through the schools of his intellectual son and grandson -- the Academy of Plato and the Lyceum of Aristotle.

I don't think that the humanities are really in a crisis, though perhaps they have a chronic illness. Bachelor's degrees in the humanities have held relatively steady since 1994 at roughly 12-13 percent of all majors. Such figures demonstrate that the health of the humanities is not robust, as measured in terms of student preferences. In contrast, the number of undergraduate business majors is steadily and constantly increasing.

So what has been the response of university and college leaders to the ill health of the humanities?

It has been to declare to applicants, students, faculty, and the public that these subjects are important. It has included more investments in humanities, from new buildings like the Mandel Center at Brandeis, to, in some cases, hiring more faculty and publicizing the humanities energetically. Dartmouth College's president, Jim Yong Kim, recently offered the hortatory remark that "Literature and the arts should not only be for kids who go to cotillion balls to make polite conversation at parties."

I couldn't agree more with the idea that the humanities are important. But this type of approach is what I call the "eat it, it's good for you" response to the curricular doldrums of humanities. That never worked with my children when it came to eating broccoli and it is even less likely to help increase humanities enrollments nationally today.

The dual-horned dilemma of higher education is the erosion of the number of majors in the humanities on the one hand and the long-feared "closing of the American mind" on the other, produced in part by the growing number of students taking what some regard as easy business majors. Yet these problems can only be solved by harnessing the power of culture, by understanding the ethno-axiological soup from which curriculums evolve and find their sustenance. Jerome Bruner has long urged educators to connect with culture, to recognize that the environment in which we operate is a value-laden behemoth whose course changes usually consume decades, a creature that won't be ignored.

It is also vital that we of the humanities not overplay our hands and claim for ourselves a uniqueness that we do not have. For example, it has become nearly a truism to say that the humanities teach "critical thinking skills." This is often correct of humanities instruction (though certainly not universally so). But critical thinking is unique neither to the humanities nor to the arts and sciences more generally. A good business education, for example, teaches critical thinking in management, marketing, accounting, finance, and other courses. More realistically and humbly, what we can say is that the humanities and sciences provide *complementary contexts* for reasoning and cultural knowledge that are crucial to functioning at a high level in the enveloping society.

Thus, admitting that critical thinking can also be developed in professional schools, we realize that it is enhanced and further developed when the thinker learns to develop analytical skills in history, different languages, philosophy, mathematics, and other contexts. The humanities offer a distinct set of problems that hone thinking skills, even if they are not the only critical thinking game in town. At my institution, Bentley University, and other institutions where most students major in professional fields, for example, English develops vocabulary and clarity of expression while, say, marketing builds on and contributes to these. Science requires empirical verification and consideration of alternatives. Accountancy builds on and contributes to these. Science and English make better business students as business courses improve thinking in the humanities and sciences.

If, like me, you believe that the humanities *do* have problems to solve, I hope you agree that they are not going to be solved by lamenting the change in culture and exhorting folks to get back on course. That's like holding your finger up to stop a tidal wave. Thinking like this could mean that new buildings dedicated to the humanities will wind up as mausoleums for the mighty dead rather than as centers of engagement with modern culture and the building of futures in contemporary society.

So what is there to do? How do we harness the power of culture to revive and heal the influence of the humanities on future generations? Remember, Popeye didn't eat his spinach only because it was good for him. He ate his spinach because he believed that it was a vital part of his ability to defend himself from the dangers and vicissitudes of life, personified in Bluto. And because he believed that it would give him a good life, represented by Olive Oyl.

Recently, an alumnus of Bentley told me over dinner, "You need business skills to get a job at our firm. But you need the arts and sciences to advance." Now, *that* is the kind of skyhook that the friends of the humanities need in order to strengthen their numbers, perception, and impact.

While I was considering the offer to come to Bentley as its next dean of arts and sciences, Brown University and another institution were considering me for professorial positions. Although I felt honored, I did not want to polish my own lamp when I felt that much in the humanities and elsewhere in higher education risk becoming a Ponzi scheme, which Wikipedia defines accurately as an "...operation that pays returns to separate investors, not from any actual profit earned by the organization, but from their own money or money paid by subsequent investors."

I wanted to make my small contribution to solving this problem, so I withdrew from consideration for these appointments to become an administrator and face the issue on the front line. And Bentley sounded like exactly the place to be, based on pioneering efforts to integrate the humanities and sciences into professional education -- such as our innovative liberal studies major, in which business majors complete a series of courses, reflections, and a capstone project emerging from their individual integration of humanities, sciences, and business.

Programs that take in students without proper concern for their future or provision for post-graduate opportunities -- how they can use what they have learned in meaningful work -- need to think about the ethics of their situation. Students no longer come mainly from the leisured classes that were prominent at the founding of higher education. Today they need to find gainful employment in which to apply all the substantive things they learn in college. Majors that give no thought to that small detail seem to assume that since the humanities are good for you, the financial commitment and apprenticeship between student and teacher is fully justified. But in these cases, the numbers of students benefit the faculty and particular programs arguably more than they benefit the students themselves. This is a Ponzi scheme. Q.E.D.

The cultural zeitgeist requires of education that it be intellectually well-balanced and focused but also useful. Providing all of these and more is not the commercialization of higher education. Rather, the combination of professional education and the humanities and sciences is an opportunity to at once (re-)engage students in the

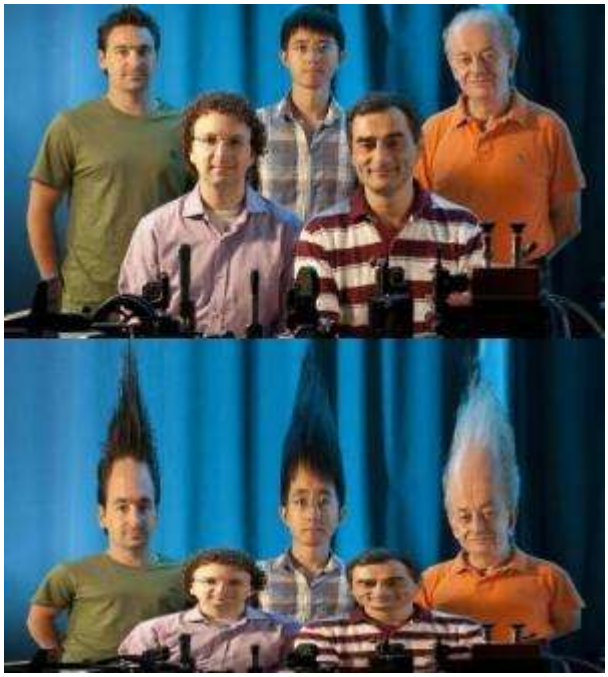
humanities and to realize Dewey's pragmatic goal of transforming education by coupling concrete objectives with abstract ideas, general knowledge, and theory.

I have labeled this call for a closer connection between the humanities and professional education the "Crucial Educational Fusion." Others have recognized this need, as examples in the new Carnegie Foundation for the Advancement of Teaching book *Rethinking Undergraduate Business Education: Liberal Learning for the Profession* illustrate. This crucial educational fusion is one solution to the lethargy of the humanities -- breaking down academic silos, building the humanities into professional curriculums, and creating a need for the humanities. Enhancing their flavor like cheese on broccoli.

Daniel L. Everett is dean of arts and sciences at Bentley University.

http://www.insidehighered.com/views/2011/08/30/essay_on_how_humanities_can_be_strengthened_by_embracing_ties_to_professional_education

From a Flat Mirror, Designer Light: Bizarre Optical Phenomena Defies Laws of Reflection and Refraction



Top, clockwise from left: Patrice Genevet, Nanfang Yu, Federico Capasso, Zeno Gaburro, and Mikhail A. Kats. Bottom: A simulation of the image that would appear in a large mirror patterned with the team's new phase mirror technology. (Credit: Photos by Eliza Grinnell and Nanfang Yu)

ScienceDaily (Sep. 1, 2011) — Exploiting a novel technique called phase discontinuity, researchers at the Harvard School of Engineering and Applied Sciences (SEAS) have induced light rays to behave in a way that defies the centuries-old laws of reflection and refraction.

The discovery, published this week in *Science*, has led to a reformulation of the mathematical laws that predict the path of a ray of light bouncing off a surface or traveling from one medium into another -- for example, from air into glass.

"Using designer surfaces, we've created the effects of a fun-house mirror on a flat plane," says co-principal investigator Federico Capasso, Robert L. Wallace Professor of Applied Physics and Vinton Hayes Senior Research Fellow in Electrical Engineering at SEAS. "Our discovery carries optics into new territory and opens the door to exciting developments in photonics technology."

It has been recognized since ancient times that light travels at different speeds through different media. Reflection and refraction occur whenever light encounters a material at an angle, because one side of the beam is able to race ahead of the other. As a result, the wavefront changes direction.

The conventional laws, taught in physics classrooms worldwide, predict the angles of reflection and refraction based only on the incident (incoming) angle and the properties of the two media.

While studying the behavior of light impinging on surfaces patterned with metallic nanostructures, the researchers realized that the usual equations were insufficient to describe the bizarre phenomena observed in the lab.

The new generalized laws, derived and experimentally demonstrated at Harvard, take into account the Capasso group's discovery that the boundary between two media, if specially patterned, can itself behave like a third medium.

"Ordinarily, a surface like the surface of a pond is simply a geometric boundary between two media, air and water," explains lead author Nanfang Yu (Ph.D. '09), a research associate in Capasso's lab at SEAS. "But now, in this special case, the boundary becomes an active interface that can bend the light by itself."

The key component is an array of tiny gold antennas etched into the surface of the silicon used in Capasso's lab. The array is structured on a scale much thinner than the wavelength of the light hitting it. This means that, unlike in a conventional optical system, the engineered boundary between the air and the silicon imparts an abrupt phase shift (dubbed "phase discontinuity") to the crests of the light wave crossing it.

Each antenna in the array is a tiny resonator that can trap the light, holding its energy for a given amount of time before releasing it. A gradient of different types of nanoscale resonators across the surface of the silicon can effectively bend the light before it even begins to propagate through the new medium.

The resulting phenomenon breaks the old rules, creating beams of light that reflect and refract in arbitrary ways, depending on the surface pattern.

In order to generalize the textbook laws of reflection and refraction, the Harvard researchers added a new term to the equations, representing the gradient of phase shifts imparted at the boundary. Importantly, in the absence of a surface gradient, the new laws reduce to the well-known ones.

"By incorporating a gradient of phase discontinuities across the interface, the laws of reflection and refraction become designer laws, and a panoply of new phenomena appear," says Zeno Gaburro, a visiting scholar in Capasso's group who was co-principal investigator for this work. "The reflected beam can bounce backward instead of forward. You can create negative refraction. There is a new angle of total internal reflection."

Moreover, the frequency (color), amplitude (brightness), and polarization of the light can also be controlled, meaning that the output is in essence a designer beam.

The researchers have already succeeded at producing a vortex beam (a helical, corkscrew-shaped stream of light) from a flat surface. They also envision flat lenses that could focus an image without aberrations.

Yu, Capasso, and Gaburro's co-authors included Patrice Genevet, Mikhail A. Kats, Francesco Aieta, and Jean-Philippe Tetienne.

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Harvard University**, via EurekAlert!, a service of AAAS.

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1. Nanfang Yu, Patrice Genevet, Mikhail A. Kats, Francesco Aieta, Jean-Philippe Tetienne, Federico Capasso, and Zeno Gaburro. **Light Propagation with Phase Discontinuities: Generalized Laws of Reflection and Refraction**. *Science*, 1 September 2011 DOI: 10.1126/science.1210713

http://www.sciencedaily.com/releases/2011/09/110901142106.htm

Giant Mars crater hints at steamy past

- 15:35 02 September 2011 by **David Shiga**

Opportunity knocks: the rover finds signs of water (Image: NASA/JPL-Caltech)

Modern Mars may be a frozen wasteland, but it has a hot and steamy past. NASA's Opportunity rover has started examining its most significant target yet, Mars's giant Endeavour crater. The initial results suggest the structure was once exposed to hot water.

Opportunity drove for three years before reaching the 22-kilometre-wide crater. Its rim exposes rocks from the earliest epoch of Martian history, when liquid water was abundant.

"We're looking at this phase of Opportunity's exploration as a whole new mission," says David Lavery of NASA Headquarters in Washington DC.

After arriving at the crater rim in early August, Opportunity investigated a rock about 1 metre across informally named Tisdale 2. It turns out to contain large quantities of zinc, more than in any other rock examined by Opportunity or its now defunct sister rover Spirit.

On Earth, hot water is known to sometimes contain a large quantity of dissolved zinc, which it can then deposit to form zinc-rich rocks. The zinc-rich rock on Endeavour's rim hints that hot water was once present there too, possibly heated by the massive impact that formed the crater, according to rover chief scientist Steve Squyres of Cornell University in Ithaca, New York.

Bright veins

The rover team is still unsure about exactly what kind of environment the rock formed in, including whether the hot water was in liquid or vapour form.

Opportunity images have also revealed bright veins cutting through other rocks on the rim. These could be places where water flowed through cracks in the rock, leaving mineral deposits behind, although the rover has not yet measured their composition.

Before examining them, the rover is first heading along the crater rim to the north-east of Tisdale 2. Measurements from orbit suggest there are clay minerals in that direction, which require water to form.

Opportunity's handlers are relishing the prospect of exploring terrain that neither Mars rover has seen before. "The excitement level within the engineering and science teams is way up," says rover scientist Ray Arvidson of Washington University in St Louis, Missouri.

http://www.newscientist.com/article/dn20858-giant-mars-crater-hints-at-steamy-past.html?full=true&print=true

NASA's Chandra Finds Nearest Pair of Supermassive Black Holes

Composite image of spiral galaxy NGC 3393. (Credit: X-ray: NASA/CXC/SAO/G. Fabbiano et al; Optical: NASA/STScI)

ScienceDaily (Sep. 1, 2011) — Astronomers using NASA's Chandra X-ray Observatory discovered the first pair of supermassive black holes in a spiral galaxy similar to the Milky Way. Approximately 160 million light years from Earth, the pair is the nearest known such phenomenon.

The black holes are located near the center of the spiral galaxy NGC 3393. Separated by only 490 light years, the black holes are likely the remnant of a merger of two galaxies of unequal mass a billion or more years ago.

"If this galaxy wasn't so close, we'd have no chance of separating the two black holes the way we have," said Pepi Fabbiano of the Harvard-Smithsonian Center for Astrophysics (CfA) in Cambridge, Mass., who led the study that appears in this week's online issue of the journal *Nature*. "Since this galaxy was right under our noses by cosmic standards, it makes us wonder how many of these black hole pairs we've been missing."

Previous observations in X-rays and at other wavelengths indicated that a single supermassive black hole existed in the center of NGC 3393. However, a long look by Chandra allowed the researchers to detect and separate the dual black holes. Both black holes are actively growing and emitting X-rays as gas falls towards them and becomes hotter.

When two equal-sized spiral galaxies merge, astronomers think it should result in the formation of a black hole pair and a galaxy with a disrupted appearance and intense star formation. A well-known example is the pair of supermassive black holes in NGC 6240, which is located about 330 million light years from Earth.

However, NGC 3393 is a well-organized spiral galaxy, and its central bulge is dominated by old stars. These are unusual properties for a galaxy containing a pair of black holes. Instead, NGC 3393 may be the first

known instance where the merger of a large galaxy and a much smaller one, dubbed a "minor merger" by scientists, has resulted in the formation of a pair of supermassive black holes. In fact, some theories say that minor mergers should be the most common way for black hole pairs to form, but good candidates have been difficult to find because the merged galaxy is expected to look so typical.

"The two galaxies have merged without a trace of the earlier collision, apart from the two black holes," said co-author Junfeng Wang, also from CfA. "If there was a mismatch in size between the two galaxies it wouldn't be a surprise for the bigger one to survive unscathed."

If this was a minor merger, the black hole in the smaller galaxy should have had a smaller mass than the other black hole before their host galaxies started to collide. Good estimates of the masses of both black holes are not yet available to test this idea, although the observations do show that both black holes are more massive than about a million suns. Assuming a minor merger occurred, the black holes should eventually merge after about a billion years.

Both of the supermassive black holes are heavily obscured by dust and gas, which makes them difficult to observe in optical light. Because X-rays are more energetic, they can penetrate this obscuring material. Chandra's X-ray spectra show clear signatures of a pair of supermassive black holes.

The NGC 3393 discovery has some similarities to a possible pair of supermassive black holes found recently by Julia Comerford of the University of Texas at Austin, also using Chandra data. Two X-ray sources, which may be due to supermassive black holes in a galaxy about two billion light years from Earth, are separated by about 6,500 light years. As in NGC 3393, the host galaxy shows no signs of disturbance or extreme amounts of star formation. However, no structure of any sort, including spiral features, is seen in the galaxy. Also, one of the sources could be explained by a jet, implying only one supermassive black hole is located in the galaxy.

"Collisions and mergers are one of the most important ways for galaxies and black holes to grow," said co-author Guido Risaliti of CfA and the National Institute for Astrophysics in Florence, Italy. "Finding a black hole pair in a spiral galaxy is an important clue in our quest to learn how this happens."

NASA's Marshall Space Flight Center in Huntsville, Ala., manages the Chandra program for NASA's Science Mission Directorate in Washington. The Smithsonian Astrophysical Observatory controls Chandra's science and flight operations from Cambridge, Mass.

For more information on the Chandra mission and this result, including images and other multimedia, visit: http://chandra.harvard.edu and http://www.nasa.gov/chandra

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **NASA**.

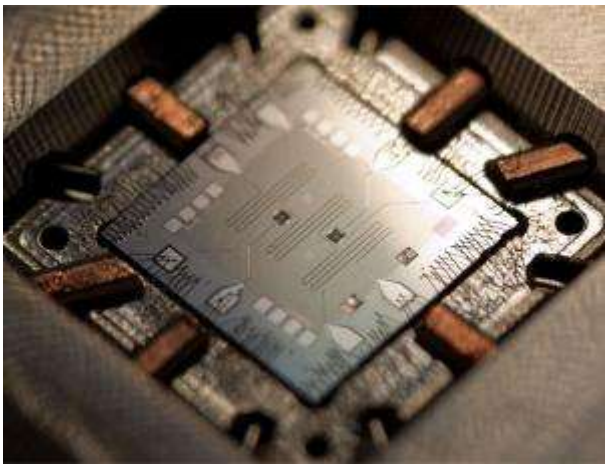
Journal Reference:

1. G. Fabbiano, Junfeng Wang, M. Elvis, G. Risaliti. **A close nuclear black-hole pair in the spiral galaxy NGC 3393**. *Nature*, 2011; DOI: 10.1038/nature10364

http://www.sciencedaily.com/releases/2011/09/110901141247.htm

Quantum computer chips pass key milestones

- 22:12 01 September 2011 by **Celeste Biever**



A quantum computer design that uses wires and circuits etched on chips is gaining ground on more established setups based on photons or ions (Image: Erik Lucero)

Quantum computer users may soon have to wrestle with their own version of the "PC or Mac?" question. A design based on superconducting electrical circuits has now performed two benchmark feats, suggesting it will be a serious competitor to rival setups using photons or ions.

"The number of runners in the race has just gone up to three," says Andrew White of the University of Queensland, Australia, who builds quantum computers based on photons and was not involved in the new result.

The defining feature of a quantum computer is that it uses quantum bits or qubits. Unlike ordinary bits, these can exist in multiple states at once, known as a superposition. They can also be entangled with each other, so their quantum states are linked, allowing them to be in a sort of "super" superposition of quantum states.

This means quantum computers could perform multiple calculations simultaneously, making them much faster than ordinary computers at some tasks.

Previously, setups using photons or trapped ions as qubits have made the most headway in early calculations. Now Matteo Mariantoni of the University of California, Santa Barbara, and colleagues have boosted the computing power of a rival design, first demonstrated in 2003, that uses tiny, superconducting wires instead.

Wire loops

Mariantoni's team used a chip embedded with micrometre-sized loops of wire made of a mixture of aluminium and rhenium. When these wires were cooled to within a whisker of absolute zero, they became superconducting, meaning their electrons coupled up as structures called "cooper pairs".

The pairs in each wire were made to resonate as an ensemble. Because each ensemble could exist as a superposition of multiple different resonating states, they acted as qubits.

Mariantoni's team entangled these qubit wires using a second type of wire, known as a bus, that snaked all around the chip. First they tuned this bus so that it took on some of the quantum information in one of the qubits. Then they transferred this information to further qubit wires, thus entangling the qubits.

Benchmark tests

The design made strides in solving calculations often used as benchmarks for testing quantum computers' capabilities.

It ran a calculation known as the quantum Fourier transform, which is a central component of the most famous quantum algorithm, known as Shor's. If Shor's were run on a system with enough qubits, it would allow huge numbers to be factorised quickly. That has not happened yet, but if it ever did, it would cause many current encryption systems to break down, since they rely on the fact that ordinary computers can't do this.

The researchers also used entangled qubits to create a system known as a "Toffoli OR phase gate", which is a critical step towards building codes that do quantum error correction. This required entangling three qubits – a first for superconducting quantum circuits. "Getting three bits to play well together is hard," says White.

Ordinary chips

The advances may seem like baby steps, since both Shor's algorithm and the Toffoli gate have been realised with relatively low numbers of photons and trapped ions.

But the reason the new result is exciting is that it could be hard to scale up these systems, which tend to be delicate and require specialised equipment, while the superconducting system uses chips like an ordinary computer. "The beautiful thing about a solid circuit is that it's something you can write using lithographic technology," says White. "It looks much easier than say ion traps or photonic approaches."

But future quantum computers might not come down to an either/or choice like that between a Mac and a PC. Instead, true to their quantum nature, they may be "superpositions" of different designs. "I don't think anybody knows what the best architecture will be," says White. "Probably we will end up using hybrids of the various approaches."

Journal reference: *Science*, DOI: 10.1126/science.1208517

http://www.newscientist.com/article/dn20857-quantum-computer-chips-pass-key-milestones.html?full=true&print=true

Word Association: Study Matches Brain Scans With Complex Thought

Princeton researchers developed a method to determine the probability of various words being associated with the object a person thought about during a brain scan. They produced color-coded figures that illustrate the probability of words within the Wikipedia article about the object the participant saw during the scan actually being associated with the object. The more red a word is, the more likely a person is to associate it, in this case, with "cow." On the other hand, bright blue suggests a strong correlation with "carrot." Black and grey "neutral" words had no specific association or were not considered at all. (Credit: Illustration courtesy of Francisco Pereira)

ScienceDaily (Sep. 1, 2011) — In an effort to understand what happens in the brain when a person reads or considers such abstract ideas as love or justice, Princeton researchers have for the first time matched images of brain activity with categories of words related to the concepts a person is thinking about. The results could lead to a better understanding of how people consider meaning and context when reading or thinking.

The researchers report in the journal *Frontiers in Human Neuroscience* that they used functional magnetic resonance imaging (fMRI) to identify areas of the brain activated when study participants thought about physical objects such as a carrot, a horse or a house. The researchers then generated a list of topics related to those objects and used the fMRI images to determine the brain activity that words within each topic shared. For instance, thoughts about "eye" and "foot" produced similar neural stirrings as other words related to body parts.

Once the researchers knew the brain activity a topic sparked, they were able to use fMRI images alone to predict the subjects and words a person likely thought about during the scan. This capability to put people's brain activity into words provides an initial step toward further exploring themes the human brain touches upon during complex thought.

"The basic idea is that whatever subject matter is on someone's mind -- not just topics or concepts, but also, emotions, plans or socially oriented thoughts -- is ultimately reflected in the pattern of activity across all areas of his or her brain," said the team's senior researcher, Matthew Botvinick, an associate professor in Princeton's Department of Psychology and in the Princeton Neuroscience Institute.

"The long-term goal is to translate that brain-activity pattern into the words that likely describe the original mental 'subject matter,'" Botvinick said. "One can imagine doing this with any mental content that can be

verbalized, not only about objects, but also about people, actions and abstract concepts and relationships. This study is a first step toward that more general goal.

"If we give way to unbridled speculation, one can imagine years from now being able to 'translate' brain activity into written output for people who are unable to communicate otherwise, which is an exciting thing to consider. In the short term, our technique could be used to learn more about the way that concepts are represented at the neural level -- how ideas relate to one another and how they are engaged or activated."

The research, which was published Aug. 23, was funded by a grant from the National Institute of Neurological Disease and Stroke, part of the National Institutes of Health.

Depicting a person's thoughts through text is a "promising and innovative method" that the Princeton project introduces to the larger goal of correlating brain activity with mental content, said Marcel Just, a professor of psychology at Carnegie Mellon University. The Princeton researchers worked from brain scans Just had previously collected in his lab, but he had no active role in the project.

"The general goal for the future is to understand the neural coding of any thought and any combination of concepts," Just said. "The significance of this work is that it points to a method for interpreting brain activation patterns that correspond to complex thoughts."

Tracking the brain's 'semantic threads'

Largely designed and conducted in Botvinick's lab by lead author and Princeton postdoctoral researcher Francisco Pereira, the study takes a currently popular approach to neuroscience research in a new direction, Botvinick said. He, Pereira and coauthor Greg Detre, who earned his Ph.D. from Princeton in 2010, based their work on various research endeavors during the past decade that used brain-activity patterns captured by fMRI to reconstruct pictures that participants viewed during the scan.

"This 'generative' approach -- actually synthesizing something, an artifact, from the brain-imaging data -- is what inspired us in our study, but we generated words rather than pictures," Botvinick said.

"The thought is that there are many things that can be expressed with language that are more difficult to capture in a picture. Our study dealt with concrete objects, things that are easy to put into a picture, but even then there was an interesting difference between generating a picture of a chair and generating a list of words that a person associates with 'chair.'"

Those word associations, lead author Pereira explained, can be thought of as "semantic threads" that can lead people to think of objects and concepts far from the original subject matter yet strangely related.

"Someone will start thinking of a chair and their mind wanders to the chair of a corporation then to Chairman Mao -- you'd be surprised," Pereira said. "The brain tends to drift, with multiple processes taking place at the same time. If a person thinks about a table, then a lot of related words will come to mind, too. And we thought that if we want to understand what is in a person's mind when they think about anything concrete, we can follow those words."

Pereira and his co-authors worked from fMRI images of brain activity that a team led by Just and fellow Carnegie Mellon researcher Tom Mitchell, a professor of computer science, published in the journal Science in 2008. For those scans, nine people were presented with the word and picture of five concrete objects from 12 categories. The drawing and word for the 60 total objects were displayed in random order until each had been shown six times. Each time an image and word appeared, participants were asked to visualize the object and its properties for three seconds as the fMRI scanner recorded their brain activity.

Matching words and brain activity with related topics

Separately, Pereira and Detre constructed a list of topics with which to categorize the fMRI data. They used a computer program developed by Princeton Associate Professor of Computer Science David Blei to condense 3,500 articles about concrete objects from the online encyclopedia Wikipedia into all the topics the articles covered. The articles included a broad array of subjects, such as an airplane, heroin, birds and manual transmission. The program came up with 40 possible topics -- such as aviation, drugs, animals or machinery -- with which the articles could relate. Each topic was defined by the words most associated with it.

The computer ultimately created a database of topics and associated words that were free from the researchers' biases, Pereira said.

"We let the software discern the factors that make up meaning rather than stipulating it ourselves," he said. "There is always a danger that we could impose our preconceived notions of the meaning words have. Plus, I can identify and describe, for instance, a bird, but I don't think I can list all the characteristics that make a bird a bird. So instead of postulating, we let the computer find semantic threads in an unsupervised manner."

The topic database let the researchers objectively arrange the fMRI images by subject matter, Pereira said. To do so, the team searched the brain scans of related objects for similar activity to determine common brain patterns for an entire subject, Pereira said. The neural response for thinking about "furniture," for example, was determined by the common patterns found in the fMRI images for "table," "chair," "bed," "desk" and "dresser." At the same time, the team established all the words associated with "furniture" by matching each fMRI image with related words from the Wikipedia-based list.

Based on the similar brain activity and related words, Pereira, Botvinick and Detre concluded that the same neural response would appear whenever a person thought of any of the words related to furniture, Pereira said. And a scientist analyzing that brain activity would know that person was thinking of furniture. The same would follow for any topic.

Using images to predict the words on a person's mind

Finally, to ensure their method was accurate, the researchers conducted a blind comparison of each of the 60 fMRI images against each of the others. Without knowing the objects the pair of scans pertained to, Pereira and his colleagues estimated the presence of certain topics on a participant's mind based solely on the fMRI data. Knowing the applicable Wikipedia topics for a given brain image, and the keywords for each topic, they could predict the most likely set of words associated with the brain image.

The researchers found that they could confidently determine from an fMRI image the general topic on a participant's mind, but that deciphering specific objects was trickier, Pereira said. For example, they could compare the fMRI scan for "carrot" against that for "cow" and safely say that at the time the participant had thought about vegetables in the first example instead of animals. In turn, they could say that the person most likely thought of other words related to vegetables, as opposed to words related to animals.

On the other hand, when the scan for "carrot" was compared to that for "celery," Pereira and his colleagues knew the participant had thought of vegetables, but they could not identify related words unique to either object.

One aim going forward, Pereira said, is to fine-tune the group's method to be more sensitive to such detail. In addition, he and Botvinick have begun performing fMRI scans on people as they read in an effort to observe the various topics the mind accesses.

"Essentially," Pereira said, "we have found a way to generally identify mental content through the text related to it. We can now expand that capability to even further open the door to describing thoughts that are not amenable to being depicted with pictures."

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Princeton University**. The original article was written by Morgan Kelly.

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1. Matthew Botvinick, Greg Detre, Francisco Pereira. **Generating Text from Functional Brain Images**. *Frontiers in Human Neuroscience*, 2011; 5 DOI: 10.3389/fnhum.2011.00072

http://www.sciencedaily.com/releases/2011/08/110831115922.htm

Portable ammonia factories could fuel clean cars

- 01 September 2011 by **Helen Knight**
- Magazine issue 2828

The fuel factory of the future (Image: Grant Delin/Millennium)

FORGET hydrogen: ammonia could be the answer to developing an emissions-free fuel for cars.

Ammonia produces just nitrogen and water vapour when burned and, unlike hydrogen, it is relatively easy to store in liquid form. That means transporting ammonia will not require costly new infrastructure, says John Fleming of SilverEagles Energy in Lubbock, Texas.

Fleming and Tim Maxwell at Texas Tech University, also in Lubbock, are developing a system to produce ammonia that can be installed in filling stations. Powered by mains electricity, it first produces hydrogen from water using electrolysis, then combines it with nitrogen from the air to produce ammonia.

To achieve this, the researchers have adapted the Haber-Bosch process used to make ammonia industrially. Their version works on a small scale and can make ammonia fairly cheaply.

In their system, a piston rapidly compresses hydrogen and nitrogen, heating the gases to 400 °C. The mixture is fed into a chamber containing an iron oxide catalyst, which sparks a reaction that further heats the gases and generates ammonia. In a third chamber, the mixture decompresses and cools down to room temperature. As it does so, it pushes against another piston, from which mechanical energy is recovered and fed back to the compressor, significantly cutting the process's power consumption.

Finally, a heat pump cools the mixture down to around -75 °C, liquefying the ammonia for collection.

The team say the whole system could fit within a standard container and could therefore be transported by truck for installation at filling stations, where it could make between 4000 and 40,000 litres of ammonia per day. Maxwell adds that the system has a modular design, so it can easily be scaled up to produce more. The ammonia could be made for just 20 cents per litre, they claim.

Edman Tsang, a chemist at the University of Oxford, says that a mobile unit that can turn water and electricity from renewable energy sources into fuel ammonia would be useful in remote areas. Fleming and Maxwell are

already working with the US army and air force, who have each expressed interest in using the technology on the battlefield.

However, Tsang is not convinced that the hydrogen needed to make ammonia can be produced economically using electrolysis. Fleming and Maxwell claim to have got round this hurdle, too (see "Hydrogen on the cheap").

Conventional cars can already make use of ammonia - they can run on a mixture that is 90 per cent gasoline and 10 per cent ammonia, says Fleming. So-called flexible-fuel vehicles, which use a mixture of gasoline and ethanol, could also be modified to run on a fuel that is up to 85 per cent ammonia. Such vehicles have sensors that constantly detect the exact proportion of gasoline and ethanol being fed through, and adjust their fuel injection and spark timing accordingly. To run on ammonia, the vehicles would need to be reprogrammed and equipped with a fuel tank capable of storing ammonia under pressure.

The team are also designing an engine that could run purely on ammonia. Called the Linear Electric Internal Combustion Engine, it is based on an existing design, known as a free piston engine, in which the burning air and ammonia mixture moves a piston forwards and backwards. This is used to drive a generator, the electricity from which powers a motor that turns the wheels.

Hydrogen on the cheap

A device being developed by John Fleming of SilverEagles Energy and Tim Maxwell from Texas Tech University could halve the cost of making hydrogen by electrolysis.

Conventional electrolysis units are made up of more than 100 2-volt cells connected in series, ensuring they can be powered by a 240-volt mains electricity supply. By using a transformer-like device to step the mains voltage down to 1.75 volts, Fleming has been able to simplify the design to use just eight cells. This makes the units much cheaper to manufacture and operate.

The pair claim their design can produce hydrogen at $2.80 per kilogram, compared to $5.20 per kg for conventional electrolysis units.

http://www.newscientist.com/article/mg21128285.100-portable-ammonia-factories-could-fuel-clean-cars.html

Humans Shaped Stone Axes 1.8 Million Years Ago: Advanced Tool-Making Methods Pushed Back in Time

Early humans were using stone hand axes as far back as 1.8 million years ago. (Credit: Pierre-Jean Texier, National Center of Scientific Research, France)

ScienceDaily (Sep. 1, 2011) — A new study suggests that *Homo erectus*, a precursor to modern humans, was using advanced toolmaking methods in East Africa 1.8 million years ago, at least 300,000 years earlier than previously thought. The study, recently published in *Nature*, raises new questions about where these tall and slender early humans originated and how they developed sophisticated tool-making technology.

Homo erectus appeared about 2 million years ago, and ranged across Asia and Africa before hitting a possible evolutionary dead-end, about 70,000 years ago. Some researchers think *Homo erectus* evolved in East Africa, where many of the oldest fossils have been found, but the discovery in the 1990s of equally old *Homo erectus* fossils in the country of Georgia has led others to suggest an Asian origin. The study in Nature does not resolve the debate but adds new complexity. At 1.8 million years ago, *Homo erectus* in Dmanisi, Georgia was still using simple chopping tools while in West Turkana, Kenya, according to the study, the population had developed hand axes, picks and other innovative tools that anthropologists call "Acheulian."

"The Acheulian tools represent a great technological leap," said study co-author Dennis Kent, a geologist with joint appointments at Rutgers University and Columbia University's Lamont-Doherty Earth Observatory. "Why didn't *Homo erectus* take these tools with them to Asia?"

In the summer of 2007, a team of French and American researchers traveled to Kenya's Lake Turkana in Africa's Great Rift Valley, where earth's plates are tearing apart and some of the earliest humans first appear. Anthropologist Richard Leakey's famous find--Turkana Boy, a *Homo erectus* teenager who lived about 1.5 million years ago -- was excavated on Lake Turkana's western shore and is still the most complete early human skeleton found so far.

Six miles from Turkana Boy, the researchers headed for Kokiselei, an archeological site where both Acheulian and simpler "Oldowan" tools had been found earlier. Their goal: to establish the age of the tools by dating the surrounding sediments. Past flooding in the area had left behind layers of silt and clay that hardened into mudstone, preserving the direction of Earth's magnetic field at the time in the stone's magnetite grains. The researchers chiseled away chunks of the mudstone at Kokiselei to later analyze the periodic polarity reversals and come up with ages. At Lamont-Doherty's Paleomagnetics Lab, they compared the magnetic intervals with other stratigraphic records to date the archeological site to 1.76 million years.

"We suspected that Kokiselei was a rather old site, but I was taken aback when I realized that the geological data indicated it was the oldest Acheulian site in the world," said the study's lead author, Christopher Lepre, a geologist who also has joint appointments at Rutgers and Lamont-Doherty. The oldest Acheulian tools previously identified appear in Konso, Ethiopia, about 1.4 million years ago, and India, between 1.5 million and 1 million years ago.

The Acheulian tools at Kokiselei were found just above a sediment layer associated with a polarity interval called the "Olduvai Subchron." It is named after Tanzania's Olduvai Gorge, where pioneering work in the 1930s by Leakey's parents, Louis and Mary, uncovered a goldmine of early human fossils. In a study in Earth and Planetary Science Letters last year, Lepre and Kent found that a well-preserved *Homo erectus* skull found on east side of Lake Turkana, at Koobi Fora Ridge, also sat above the Olduvai Subchron interval, making the skull and Acheulian tools in West Turkana about the same age.

Anthropologists have yet to find an Acheulian hand axe gripped in a *Homo erectus* fist but most credit *Homo erectus* with developing the technology. Acheulian tools were larger and heavier than the pebble-choppers used previously and also had chiseled edges that would have helped *Homo erectus* butcher elephants and other scavenged game left behind by larger predators or even have allowed the early humans to hunt such prey themselves. "You could whack away at a joint and dislodge the shoulder from the arm, leg or hip," said Eric Delson, a paleoanthropologist at CUNY's Lehman College who was not involved in the study. "The tools allowed you to cut open and dismember an animal to eat it."

The skill involved in manufacturing such a tool suggests that *Homo erectus* was dexterous and able to think ahead. At Kokiselei, the presence of both tool-making methods -- Oldowan and Acheulian-- could mean that *Homo erectus* and its more primitive cousin Homo habilis lived at the same time, with *Homo erectus* carrying the Acheulian technology to the Mediterranean region about a million years ago, the study authors hypothesize. Delson wonders if *Homo erectus* may have migrated to Dmanisi, Georgia, but "lost" the Acheulian technology on the way.

The East African landscape that *Homo erectus* walked from about 2 million to 1.5 million years ago was becoming progressively drier, with savanna grasslands spreading in response to changes in the monsoon rains. "We need to understand also the ancient environment because this gives us an insight into how processes of evolution work -- how shifts in early human biology and behavior are potentially caused by changes in the climate, vegetation or animal life that is particular to a habitat," said Lepre. The team is currently excavating a more than 2 million year old site in Kenya to learn more about the early Oldowan period.

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **The Earth Institute at Columbia University**.

Journal Reference:

1. Christopher J. Lepre, Hélène Roche, Dennis V. Kent, Sonia Harmand, Rhonda L. Quinn, Jean-Philippe Brugal, Pierre-Jean Texier, Arnaud Lenoble, Craig S. Feibel. **An earlier origin for the Acheulian**. *Nature*, 2011; 477 (7362): 82 DOI: 10.1038/nature10372

http://www.sciencedaily.com/releases/2011/08/110831205942.htm

Evolutionary theory can make street life better

- 29 August 2011 by **David Sloan Wilson**
- Magazine issue 2827.

Can we use evolutionary biology to improve people's lives?

A FEW years ago, it struck me that Darwin's theory of evolution could be used to make our lives better in a practical sense. As someone who has spent a lifetime studying evolution, this was a road to Damascus moment. Reborn, I left my ivory tower to see if I could make a difference in my own city of Binghamton, New York, and worldwide through the creation of the Evolution Institute, the world's first evolutionary think tank.

My new mission was not a complete break from what I had been doing before. Throughout my career, I have studied the fundamental problem of how altruism, cooperation and other traits that are good for the group can evolve in any species. I have also studied the evolutionary origins of human characteristics such as gossip, decision-making, physical attractiveness and religion. But that was all academic research: how would my ideas fare on the streets of Binghamton?

My team's first goal was to measure "prosociality" - any behaviour geared towards the care and welfare of others or the promotion of society - to see if we might encourage more of it. We did this using a variety of methods, including experimental games, door-to-door surveys and questionnaires aimed at schoolchildren, and by observing the frequency of spontaneous prosocial acts such as people picking up and posting a stamped addressed envelope left on the sidewalk, or the extent to which people decorated their houses during Halloween or Christmas. The data was geographically referenced, which enabled us to generate topographical maps depicting prosociality across the whole city.

The results were striking. If prosocial individuals had been evenly distributed throughout the city - as you might expect - then the maps would have looked like a flat plain. Instead, they revealed a rugged landscape with hills representing concentrations of highly prosocial people and valleys for areas where people appeared to care little for others or society.

Why is prosociality clustered in this way? This is where evolutionary theory can help. As an academic evolutionist, I knew that prosociality can evolve in any species when highly prosocial individuals are able to interact with each other and avoid interacting with selfish individuals - in other words, when those who give also receive. Our surveys show that this is what is happening in Binghamton. The most caring and altruistic individuals receive the most social support from multiple sources, including family, neighbourhood, school, religion, and through extracurricular activities such as sports and arts. Groups that satisfy this basic condition for prosociality are likely to thrive.

That doesn't explain why prosociality is common in some areas and rare in others, though. Do people who are genetically predisposed towards altruism tend to flock together? Or do people become more altruistic when they interact with others who display this trait? Or are external environmental conditions the major influence? Research shows that all three factors play a role. Whatever genetic predispositions people have, their prosociality changes according to where they are and who they are with. Much depends on their social environment.

We demonstrated this in Binghamton, when we surveyed dozens of young people whose families had moved home between 2006 and 2009. Some moved from valleys to hills, others from hills to valleys. In each case their prosociality changed to match their new environment: those moving to neighbourhoods with greater

cohesion between residents became more inclined to put the interests of others before their own, those moving to more splintered neighbourhoods became less so.

Promoting prosociality is a good idea not only as an end in itself, but because living in a caring, supportive neighbourhood carries many additional benefits, from lower crime rates to a healthier developmental environment for children. With this in mind, we have started several experiments to test whether we can turn Binghamton's valleys into hills. In one ambitious project, the Design Your Own Park initiative, we're giving residents the opportunity to cooperate with their neighbours by turning neglected spaces into parks of their own design. Most people scarcely know their neighbours, but there's nothing like a common goal to bring people together.

The science behind Design Your Own Park is based on work by Elinor Ostrom, who won the 2009 Nobel prize in economics for showing - in contrast to conventional economic wisdom - that groups of people are capable of managing common resources when certain conditions are met. The conditions, in a nutshell, are that the group and its purpose must be clearly defined; costs and benefits must be equally shared; decision-making must be by consensus; misconduct should be monitored; sanctions should start out mild and escalate only as needed; conflict resolution should be fast and fair; the group must have the authority to manage its affairs; and the relationship of the group with others must be appropriately structured. Ostrom's work is relevant to any group striving for a common goal, including designing a neighbourhood park. One year into our initiative, five schemes are up and running and showing great promise, though it is too early yet for a real assessment of success.

In another project, we are advising the Binghamton City School District in the design of an educational programme for high-school students who are at risk of falling behind - to be eligible they must have flunked three of their classes during the previous year. Called the Regents Academy, it too makes use of the Ostrom principles, since schools are also social groups whose members must cooperate to achieve their objectives. As well as these principles, we draw on research into how people function in safe and harsh environments and how they respond to short-term and long-term goals.

A group that functions well is a bit like an organism with numerous organs: remove any single organ and the organism dies. The Regents Academy has all the necessary organs to function as an effective group, and it seems to be working. During its first year, not only did its students greatly outperform an equivalent group of at-risk high-school students, but they also performed on a par with average Binghamton high-school students on state-mandated exams.

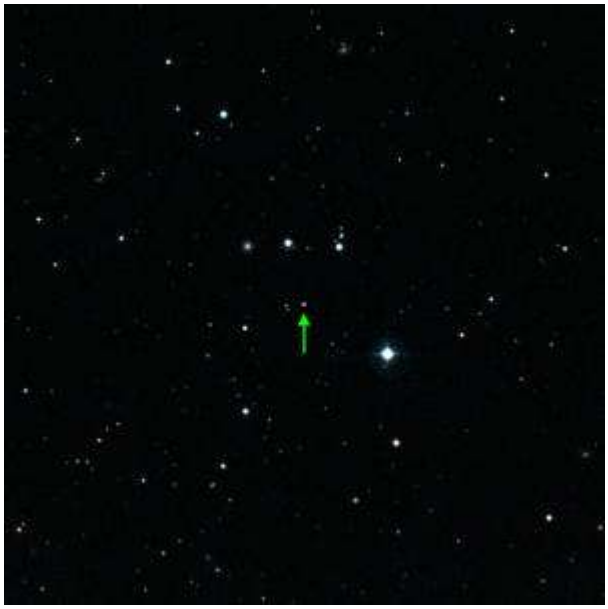
This proves that educational policy informed by evolutionary theory can make a difference on the ground. Indeed, I am convinced that a Darwinian perspective can improve policy in many arenas. At the Evolution Institute we are using evolutionary science to help address a whole range of issues in addition to education, such as risky adolescent behaviour, failed nation states and human regulatory systems at all scales.

This kind of work is what evolutionary science should be all about. Evolution is fundamentally about the relationship between organisms and their environments. Field studies - rather than lab-based research - should form the foundation of research on all species, humans included. Yet the vast majority of studies in the human-related sciences are not based on field research, and the most field-oriented disciplines, such as sociology and cultural anthropology, have been least receptive to the modern evolutionary perspective.

What we have done in Binghamton is to establish a field site for human-related evolutionary research. It could prove as useful as Tanzania's Gombe national park has been for the study of chimpanzees and the Galapagos Islands for the study of finches.

http://www.newscientist.com/article/mg21128270.300-evolutionary-theory-can-make-street-life-better.html

The Star That Should Not Exist



At the center of this picture is a very unremarkable looking faint star, too faint to be seen through all but the largest amateur telescopes. This ancient star, in the constellation of Leo (The Lion), is called SDSS J102915+172927 and has been found to have the lowest amount of elements heavier than helium of all stars yet studied. It has a mass smaller than that of the Sun and is probably more than 13 billion years old. (Credit: ESO/Digitized Sky Survey 2)

ScienceDaily (Sep. 1, 2011) — A faint star in the constellation of Leo (The Lion), called SDSS J102915+172927 [1], has been found to have the lowest amount of elements heavier than helium (what astronomers call "metals") of all stars yet studied. It has a mass smaller than that of the Sun and is probably more than 13 billion years old.

"A widely accepted theory predicts that stars like this, with low mass and extremely low quantities of metals, shouldn't exist because the clouds of material from which they formed could never have condensed," [2] said Elisabetta Caffau (Zentrum fur Astronomie der Universitat Heidelberg, Germany and Observatoire de Paris, France), lead author of the paper. "It was surprising to find, for the first time, a star in this 'forbidden zone', and it means we may have to revisit some of the star formation models."

The team analysed the properties of the star using the X-shooter and UVES instruments on the VLT [3]. This allowed them to measure how abundant the various chemical elements were in the star. They found that the proportion of metals in SDSS J102915+172927 is more than 20 000 times smaller than that of the Sun [4][5].

"The star is faint, and so metal-poor that we could only detect the signature of one element heavier than helium -- calcium -- in our first observations," said Piercarlo Bonifacio (Observatoire de Paris, France), who supervised the project. "We had to ask for additional telescope time from ESO's Director General to study the star's light in even more detail, and with a long exposure time, to try to find other metals."

Cosmologists believe that the lightest chemical elements -- hydrogen and helium -- were created shortly after the Big Bang, together with some lithium [6], while almost all other elements were formed later in stars.

Supernova explosions spread the stellar material into the interstellar medium, making it richer in metals. New stars form from this enriched medium so they have higher amounts of metals in their composition than the older stars. Therefore, the proportion of metals in a star tells us how old it is.

"The star we have studied is extremely metal-poor, meaning it is very primitive. It could be one of the oldest stars ever found," adds Lorenzo Monaco (ESO, Chile), also involved in the study.

Also very surprising was the lack of lithium in SDSS J102915+172927. Such an old star should have a composition similar to that of the Universe shortly after the Big Bang, with a few more metals in it. But the team found that the proportion of lithium in the star was at least fifty times less than expected in the material produced by the Big Bang.

"It is a mystery how the lithium that formed just after the beginning of the Universe was destroyed in this star." Bonifacio added.

The researchers also point out that this freakish star is probably not unique. "We have identified several more candidate stars that might have metal levels similar to, or even lower than, those in SDSS J102915+172927. We are now planning to observe them with the VLT to see if this is the case," concludes Caffau.

Notes

[1] The star is catalogued in the Sloan Digital Sky Survey or SDSS. The numbers refer to the object's position in the sky.

[2] Widely accepted star formation theories state that stars with a mass as low as SDSS J102915+172927 (about 0.8 solar masses or less) could only have formed after supernova explosions enriched the interstellar medium above a critical value. This is because the heavier elements act as "cooling agents," helping to radiate away the heat of gas clouds in this medium, which can then collapse to form stars. Without these metals, the pressure due to heating would be too strong, and the gravity of the cloud would be too weak to overcome it and make the cloud collapse. One theory in particular identifies carbon and oxygen as the main cooling agents, and in SDSS J102915+172927 the amount of carbon is lower than the minimum deemed necessary for this cooling to be effective.

[3] X-shooter (http://www.eso.org/public/news/eso0920/) and UVES (http://www.eso.org/sci/facilities/paranal/instruments/uves/) are VLT spectrographs -- instruments used to separate the light from celestial objects into its component colours and allow detailed analysis of the chemical composition. X-shooter can capture a very wide range of wavelengths in the spectrum of an object in one shot (from the ultraviolet to the near-infrared). UVES is the Ultraviolet and Visual Echelle Spectrograph, a high-resolution optical instrument.

[4] The star HE 1327-2326, discovered in 2005, has the lowest known iron abundance, but it is rich in carbon. The star now analysed has the lowest proportion of metals when all chemical elements heavier than helium are considered.

[5] ESO telescopes have been deeply involved in many of the discoveries of the most metal-poor stars. Some of the earlier results were reported in eso0228 (http://www.eso.org/public/news/eso0920/) and eso0723 (http://www.eso.org/public/news/eso0723/) and the new discovery shows that observations with ESO telescopes have let astronomers make a further step closer to finding the first generation of stars.

[6] Primordial nucleosynthesis refers to the production of chemical elements with more than one proton a few moments after the Big Bang. This production happened in a very short time, allowing only hydrogen, helium

and lithium to form, but no heavier elements. The Big Bang theory predicts, and observations confirm, that the primordial matter was composed of about 75% (by mass) of hydrogen, 25% of helium, and trace amounts of lithium.

More information

This research was presented in a paper, "An extremely primitive halo star," by Caffau et al. to appear in the 1 September 2011 issue of the journal *Nature*.

The team is composed of Elisabetta Caffau (Zentrum fur Astronomie der Universitat Heidelberg [ZAH], Germany and GEPI -- Observatoire de Paris, Universite Paris Diderot, CNRS, France [GEPI]), Piercarlo Bonifacio (GEPI), Patrick François (GEPI and Universite de Picardie Jules Verne, Amiens, France), Luca Sbordone (ZAH, Max-Planck Institut fur Astrophysik, Garching, Germany, and GEPI), Lorenzo Monaco (ESO, Chile), Monique Spite (GEPI), François Spite (GEPI), Hans-G. Ludwig (ZAH and GEPI), Roger Cayrel (GEPI), Simone Zaggia (INAF, Osservatorio Astronomico di Padova, Italy), François Hammer (GEPI), Sofia Randich (INAF, Osservatorio Astrofisico di Arcetri, Firenze, Italy), Paolo Molaro (INAF, Osservatorio Astronomico di Trieste, Italy), and Vanessa Hill (Universite de Nice-Sophia Antipolis, Observatoire de la Cote d'Azur, CNRS, Laboratoire Cassiopee, Nice, France).

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **European Southern Observatory - ESO**.

Journal Reference:

1. Elisabetta Caffau, Piercarlo Bonifacio, Patrick François, Luca Sbordone, Lorenzo Monaco, Monique Spite, François Spite, Hans-G. Ludwig, Roger Cayrel, Simone Zaggia, François Hammer, Sofia Randich, Paolo Molaro, Vanessa Hill. **An extremely primitive star in the Galactic halo**. *Nature*, 2011; 477 (7362): 67 DOI: 10.1038/nature10377

http://www.sciencedaily.com/releases/2011/08/110831155340.htm

New power wave heads out to sea

- 26 August 2011 by **Phil McKenna**
- Magazine issue 2827.

Any wave will do for P2 (Image: Pelamis Wave Power)

An explosion of designs for harvesting wave energy could make the process competitive at last – and they're heading out to the ocean for testing

WRINGING electricity from the sea is no small task. But as firms start to test their wave-energy harvesters in the open ocean that could be about to change.

Heaving water holds 40 times more energy than air moving at the same speed, and sea states change more slowly than breezes, making it easier for utilities to predict the availability of energy. Yet the tools needed to make use of the sea's energy are gargantuan.

Pelamis Wave Power's wave energy device, P2, is a case in point. Currently stored at the Leith Docks in Edinburgh, UK, it uses spools of steel cable several times human height, and floats that are as big as a car. But this is just window dressing for the machine itself: a red rig that looks like a 180-metre-long subway train.

Pelamis and Aquamarine Power, also based in Edinburgh, are the big players in what remains a small industry of generating energy from waves. Each is now fielding full-scale prototypes that could make wave energy competitive in terms of cost with other renewable energy sources, such as offshore wind.

Alongside them are dozens of smaller competitors, building a menagerie of strange devices that they hope will leapfrog ahead of existing machines in the race to provide inexpensive power from the sea. "Wave energy has been talked about for hundreds of years," says Neil Kermode, managing director of the European Union-funded European Marine Energy Centre (EMEC). "Now it's actually starting to happen."

In the UK, the waters around the Orkney Islands off northern Scotland, home to some of the world's cruellest weather, are used as EMEC's proving grounds, as they offer a stiff test for wave-energy devices. As Kermode puts it: "This is the playground for the big boys."

For all its impressive size, on the inside the P2 looks more like a data centre than a ship's hull. Duplicate server racks, fibre-optic communication systems and emergency power supplies allow programmers to upload software on the fly without interrupting power production.

The P2 generates energy when its large floating tubes, connected by hinged joints, bob in the waves, moving hydraulic rams that pump high-pressure fluid to drive turbine. And while the hardware has been upgraded from previous prototypes, it is the algorithm controlling them that makes the difference. By decreasing resistance in the rams when waves are small and increasing it when they are larger, the algorithm maximises energy production in any sea state. As a result, the P2 produces 750 kilowatts of electricity - twice as much as prior prototypes.

"It's the active control of these algorithms that allows us to tune the machine to be in resonance regardless of wave conditions," says Pelamis engineer Ross Henderson.

Last month, Aquamarine Power finished the construction of its second full-scale wave power device, the Oyster 800. This consists of a hinged flap that sticks out of the water and is pushed shut with each passing wave. When the flap moves, it drives hydraulic pistons that deliver high-pressure water via a pipeline to an onshore turbine. With an output of 800 kilowatts, the device is built to be 2.5 times as powerful as its predecessor (see "The ocean is your oyster").

"If you can get that sort of level of performance improvement then the economics suddenly start to look a lot more favourable," says Stephen Wyatt, head of technology acceleration at The Carbon Trust, a UK-government-funded organisation charged with catalysing a low-carbon economy.

A study published by The Carbon Trust in July estimated the cost of energy harvested from waves at 43 pence per kilowatt-hour, or almost three times the cost of offshore wind. To become cost competitive with other sources of renewable energy, companies will have to find ways to squeeze more power out of their devices, says Wyatt.

Meanwhile, a host of start-up companies are heading for EMEC's "nursery" - a test facility built in sheltered waters for designs that are not yet ready for the open ocean - each hoping their device will be the next game changer.

One of the most promising, according to a three-year study by The Carbon Trust, is Anaconda by Checkmate Seaenergy, based in Sheerness, UK. This is a snake-like rubber tube filled with water that floats just below the surface. As waves hit the front of the device they squeeze the tube, creating a bulge of water that travels along it. When the bulge reaches the end, the pressurised water drives a turbine.

An 8-metre long prototype has been tested, but the firm says it will be several years before its full-scale 1-megawatt device, which would be 150 metres long, is ready.

An equally unusual machine, the 1600-tonne Penguin, will soon begin testing at EMEC. Built by Finnish company Wello, the 500-kilowatt rig has an asymmetrically shaped hull that causes it to roll, heave and pitch - much like the stilted stride of a penguin - with each passing wave. The movement spins a flywheel inside the hull, driving a generator.

With such devices arriving with increasing frequency, it's too early to tell which technology will win out in the end. "That is part of the excitement," Kermode says. "It may be something completely new or variations on something we have already seen."

The ocean is your oyster

The Oyster 800, the newest wave energy device developed by UK-based Aquamarine Power, produces 250 per cent more energy than its predecessor. Most of the improvement came from making the hinged flap that harnesses wave energy wider - it is now 26 metres wide and 12 metres high.

Gains also came from subtle changes in the device's design, such as wider edges on the flap's sides to reduce water turbulence. Conversely, tapering Oyster's width along the top of its flap allows it to cut through the water more efficiently, boosting energy output by 3 per cent.

"I'm confident that there is still more power to get out," says Matthias Haag of Aquamarine Power.

http://www.newscientist.com/article/mg21128276.100-new-power-wave-heads-out-to-sea.html

Cutting Soot Emissions: Fastest, Most Economical Way to Slow Global Warming?

Reducing soot emissions from diesel engines and other sources could slow melting of sea ice in the Arctic faster and more economically than any other quick fix, new research suggests. (Credit: © lustil / Fotolia)

ScienceDaily (Sep. 1, 2011) — A new study of dust-like particles of soot in the air -- now emerging as the second most important, but previously overlooked, factor in global warming -- provides fresh evidence that reducing soot emissions from diesel engines and other sources could slow melting of sea ice in the Arctic faster and more economically than any other quick fix, a scientist reported in Denver, Colorado on August 31, 2011.

In a presentation at the 242nd National Meeting & Exposition of the American Chemical Society (ACS), Mark Z. Jacobson, Ph.D., cited concerns that continued melting of sea ice above the Arctic Circle will be a tipping point for Earth's climate, a point of no return. That's because the ice, which reflects sunlight and heat back into space, would give way to darker water that absorbs heat and exacerbates warming. And there is no known way to make the sea refreeze in the short term.

Jacobson's calculations indicate that controlling soot could reduce warming above parts of the Arctic Circle by almost 3 degrees Fahrenheit within 15 years. That would virtually erase all of the warming that has occurred in the Arctic during the last 100 years.

"No other measure could have such an immediate effect," said Jacobson, who is with Stanford University. "Soot emissions are second only to carbon dioxide (CO_2) in promoting global warming, but its effects have been underestimated in previous climate models. Consequently, soot's effect on climate change has not been adequately addressed in national and international global warming legislation. Soot emissions account for about 17 percent of global warming, more than greenhouse gases like methane. Soot's contribution, however, could be reduced by 90 percent in 5-10 years with aggressive national and international policies."

Soot or "black carbon" consists of particles, nearly invisible on an individual basis, released in smoke from combustion of fossil fuels and biofuels. Major sources include exhaust from diesel cars, buses, trucks, ships, aircraft, agricultural machines, construction equipment and the wood/animal dung fires that hundreds of millions of people in developing countries use for used for cooking and heating. Black carbon particles become suspended in the atmosphere and absorb sunlight, just like a black t-shirt on a sunny day. The particles then radiate that heat back into the air around it. Black carbon also can absorb light reflected from Earth's surface, which helps make it such a potent warming agent.

The good news is that decreasing soot could have a rapid effect, Jacobson said. Unlike carbon dioxide, which remains in the atmosphere for years, soot disappears within a few weeks, so that there is no long-term reservoir with a continuing warming effect. And the technology for controlling black carbon, unlike that for controlling CO_2, already is available at relatively modest cost. Diesel particulate filters, for instance, can remove soot from car and truck exhaust. Government and other agencies also are trying to introduce low-soot cookstoves in developing countries. "Converting gasoline- and diesel-burning cars and trucks to electric or hydrogen vehicles and reducing emissions from diesel generators could have an immediate effect on warming," according to Jacobson.

Jacobson, who developed the first detailed climate model to include the global effects of soot, reported on use of the model to gain new insights into the effects of soot particles trapped inside and between the water droplets that make up clouds. Previous research on black carbon and climate overlooked that topic. Jacobson said the information is important because black carbon within clouds makes the clouds "burn off" and disappear over heavily polluted urban and other areas. Climate models that ignore this "cloud absorption" phenomenon underestimate the effects of black carbon on climate.

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **American Chemical Society**.

http://www.sciencedaily.com/releases/2011/08/110831205919.htm

Anti-dengue mosquitoes released in Australia

- 18:00 24 August 2011 by **Wendy Zukerman**

Harmless bite (Image: Patrick Lorne/Sunset/Rex Features)

Some 300,000 mosquitoes with the potential to block the spread of dengue fever have been released in Australia, in a large-scale trial of one of the most promising techniques to rid the world of the disease.

Dengue fever infects around 100 million people in the tropics each year, killing 40,000 people annually. Insecticides and nets provide the most effective means to control the disease at present, says Scott O'Neill at Monash University in Melbourne, Australia, but the dengue virus's range continues to grow. In 2009, for instance, it reached Buenos Aires in Argentina for the first time, while France reported its first locally acquired case of dengue fever in 2010.

Last year, O'Neill and colleagues announced plans to release *Aedes aegypti* mosquitoes infected with a fruit-fly bacterium called *Wolbachia*. The bacterium makes the mosquitoes less able to carry the dengue virus, and it could therefore limit dengue transmission if it were to become widespread in the mosquito population.

Fast spreader

In principle *Wolbachia* can spread quickly as infected male mosquitoes produce viable offspring only if they breed with *Wolbachia*-infected females. What's more, all the offspring of infected females will carry *Wolbachia*, whether the male parent is a carrier or not.

To test this, O'Neill's team began releasing the mosquitoes in Queensland in northeastern Australia, which has experienced relatively severe dengue fever outbreaks in recent years. First they released around 2500 *A. aegypti* mosquitoes carrying *Wolbachia* into two outdoor enclosures which mimicked a typical north Queensland backyard – complete with potted tropical plants and trees. For every infected mosquito, one uninfected mosquito was also released.

After 30 days, the entire population in one cage had become infected with *Wolbachia*, and after 80 days all the mosquitoes in the second cage were also infected.

On the back of that success, the team released almost 300,000 *Wolbachia*-infected mosquitoes in two towns in northern Queensland: Yorkeys Knob and Gordonvale.

'Pleased as punch'

After four months, the team found that all of the mosquitoes they trapped in Yorkeys Knob and 90 per cent of those trapped in Gordonvale were carrying *Wolbachia*. "We were pleased as punch," says team member Scott Ritchie at James Cook University in Cairns, Queensland.

However, two weeks later infection rates had fallen to 95 per cent in Yorkeys Knob and 81 per cent in Gordonvale. The researchers speculate that this might reflect the onset of the dry season, which brought uninfected mosquitoes from surrounding areas into the towns.

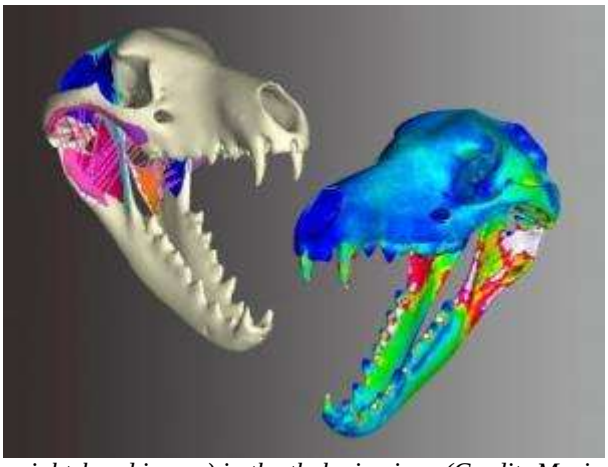
O'Neill's team also monitored neighbouring towns to see whether *Wolbachia* spread beyond the release area. Evidence of spread could prove legally problematic if one country wants to use *Wolbachia* in an anti-dengue strategy but a neighbouring country does not. However, infected larvae were detected beyond the town limits on just three occasions. "We don't expect *Wolbachia* to establish in those mosquito communities," O'Neill says.

He says the team is now ready for the final test: releasing *Wolbachia*-infected mosquitoes in areas with a high incidence of dengue. Pending government approval, the team will begin trials in Thailand, Vietnam, Indonesia or Brazil within twelve months.

Journal reference: *Nature*, DOI: 10.1038/nature10355

http://www.newscientist.com/article/dn20827-antidengue-mosquitoes-released-in-australia.html?full=true&print=true

Tasmanian Tiger's Jaw Was Too Small to Attack Sheep, Study Shows



Digital stress tests reveal weakness (red/white areas in right-hand image) in the thylacine jaw. (Credit: Marie Attard)

ScienceDaily (Sep. 1, 2011) — Australia's iconic thylacine, or Tasmanian tiger, was hunted to death in the early Twentieth century for allegedly killing sheep; however, a new study published in the Zoological Society of London's *Journal of Zoology* has found that the tiger had such weak jaws that its prey was probably no larger than a possum.

"Our research has shown that its rather feeble jaw restricted it to catching smaller, more agile prey," said lead author Marie Attard, of the University of New South Wales Computational Biomechanics Research Group. "That's an unusual trait for a large predator like that, considering its substantial 30 kg body mass and carnivorous diet. As for its supposed ability to take prey as large as sheep, our findings suggest that its reputation was at best overblown.

"While there is still much debate about its diet and feeding behaviour, this new insight suggests that its inability to kill large prey may have hastened it on the road to extinction."

Thylacines were top predators that once ranged across Australia and New Guinea but were found only in Tasmania by the time of European settlement. The resulting loss of habitat and prey, and a bounty paid to hunters to kill them, have been blamed for the demise of this carnivorous marsupial.

Despite its obvious decline, it did not receive official protection from the Tasmanian Government until two months before the last known individual died at Hobart Zoo on 7th September, 1936.

Using advanced computer modelling techniques, the UNSW research team were able to simulate various predatory behaviours, including biting, tearing and pulling, to predict patterns of stress in the skull of a thylacine and those of Australasia's two largest remaining marsupial carnivores, the Tasmanian devil and the spotted-tailed quoll.

The thylacine's skull was highly stressed compared to those of its close living relatives in response to simulations of struggling prey and bites using their jaw muscles.

"By comparing the skull performance of the extinct thylacine with those of closely related, living species we can predict the likely body size of its prey," says the director of the Computational Biomechanics Research

Group, Dr Stephen Wroe. "We can be pretty sure that thylacines were competing with other marsupial carnivores to prey on smaller mammals, such as bandicoots, wallabies and possums.

"Especially among large predators, the more specialised a species becomes the more vulnerable is it to extinction. Just a small disturbance to the ecosystem, such as those resulting from the way European settlers altered the land, may have been enough to tip this delicately poised species over the edge."

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Wiley-Blackwell**, via EurekAlert!, a service of AAAS.

Journal Reference:

1. M.R.G. Attard, U. Chamoli, T.L. Ferrara, T.L. Rogers and S. Wroe. **Skull mechanics and implications for feeding behaviour in a large marsupial carnivore guild: the thylacine, Tasmanian devil and spotted-tailed quoll**. *Journal of Zoology*, 31 August 2011 DOI: 10.1111/j.1469-7998.2011.00844.x

http://www.sciencedaily.com/releases/2011/08/110831210058.htm

First link between climate patterns and civil conflict

- 24 August 2011 by **Catherine Brahic**
- Magazine issue 2827.

Peru's civil war started in an El Niño year (Image: Enrique Castro-Menoivil/Reuters/Corbis)

THE Peruvian highlands were hit hard by El Niño in 1982, and crops were destroyed. The same year, guerrilla attacks by the Shining Path movement erupted into a civil war that would last 20 years. Random coincidence? Possibly not.

The first study to link global climate patterns to the onset of civil conflict places El Niño on a par with factors like poverty and social exclusion.

Solomon Hsiang, a researcher in international affairs at Princeton University, and colleagues looked at data on conflicts between 1950 and 2004 that killed more than 25 people in a year. They compared El Niño years, which happen roughly every five years, with La Niña years. El Niño tends to bring hotter, drier conditions - and La Niña cooler ones - to tropical countries, but both have less of an influence on temperate countries.

The analysis included 175 countries and 234 conflicts, over half of which caused more than 1000 deaths. It found that the risk of conflict in tropical countries rose from 3 per cent during La Niña years to 6 per cent

during El Niño years. The effect was absent from countries only weakly affected by these climate cycles (*Nature*, DOI: 10.1038/nature10311).

"I was surprised by the strength of the effect," says Halvard Buhaug of the Peace Research Institute Oslo in Norway. "Doubling of risk is a large increase, about on a par with poverty and ethno-political exclusion."

Buhaug has been sceptical of similar studies, and though he finds the statistics convincing, he says he is puzzled, as the study offers no explanation for how El Niño might exert an influence over stressed human societies.

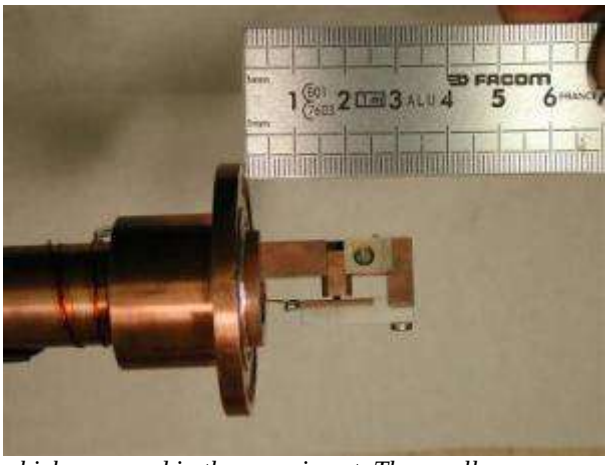
Hsiang's team found that El Niño appeared to have an immediate effect - in their analysis, conflicts erupted within months of the onset of El Niño events - but the correlation was independent of local weather events like drought, which can bring famine and increased tension.

Hsiang cannot yet explain what is causing the link. One possibility is that international markets spread climate signals around the world. For instance, widespread drought in an El Niño year could cause global food prices to rise.

But as Andrew Solow of the Woods Hole Oceanographic Institution in Massachusetts points out, "People do not start wars simply because they are hot." And until we know what it is about El Niño that increases the likelihood of conflict, it will be impossible to say whether this means we should expect more unrest due to climate change.

http://www.newscientist.com/article/mg21128274.500-first-link-between-climate-patterns-and-civil-conflict.html

Understanding Next-Generation Electronic Devices: Smallest Atomic Displacements Ever



This photo shows the sample holder, made of copper, which was used in the experiment. The small gray crystal of TbMnO3 that was studied, is in the center, between two electrodes to apply an electric field. (Credit: Image courtesy of Luigi Paolasini)

ScienceDaily (Sep. 1, 2011) — An international team of scientists has developed a novel X-ray technique for imaging atomic displacements in materials with unprecedented accuracy. They have applied their technique to determine how a recently discovered class of exotic materials -- multiferroics -- can be simultaneously both magnetically and electrically ordered. Multiferroics are also candidate materials for new classes of electronic devices.

The discovery, a major breakthrough in understanding multiferroics, is published in *Science* dated 2 September 2011.

The authors comprise scientists from the European Synchrotron Radiation Facility (ESRF) in Grenoble (France), the University of Oxford and the University College London (both UK). Helen Walker from the ESRF is the main author of the publication.

Everybody is familiar with the idea that magnets are polarized with a north and a south pole, which is understood to arise from the alignment of magnet moments carried by atoms in magnetic materials. Certain other materials, known as ferroelectrics, exhibit a similar effect for electrical polarisation. The exotic "multiferroic" materials combine both magnetic and ferroelectric polarizations, and can exhibit a strong coupling between the two phenomena.

This leads to the strange effect that a magnetic field can electrically polarise the material, and an electric field magnetise it. A class of strong multiferroics was discovered ten years ago and has since led to a new, rapidly growing field of research, also motivated by the promise of their exotic properties for new electronic devices. One example is a new type of electronic memory, in which an electric field writes data into the memory and a magnetic detector is used to read it. This process is faster, and uses less energy than today's hard disk drives.

However, the origin of the electric polarisation in multiferroics remained mostly elusive to date. The team's work unambiguously shows that the polarization in the multiferroic studied proceeds from the relative displacement of charges of different signs, rather than the transfer of charge from one atom to another.

As the displacement involves a high number of electrons, even small distances can lead to significant polarisation. The actual distance of the displacement still came as a surprise: about 20 femtometres, or about

1/100,000th of the distance between the atoms in the material. Measuring such small displacements was actually believed to be impossible.

"I think that everyone involved was surprised, if not staggered, by the result that we can now image the position of atoms with such accuracy. The work is testament to the fantastic facilities available in Grenoble to the UK science community," says Prof. Des McMorrow, Deputy Director of the London Centre for Nanotechnology, leader of the UCL part of the project.

Walker and her colleagues developed a smart new experimental technique exploiting the interference between two competing processes: charge and magnetic scattering of a powerful, polarized X-ray beam. They studied a single crystal of TbMnO3 which shows a strong multiferroic coupling at temperatures below 30K, and were able to measure the displacements of specific atoms within it with an accuracy approaching one femtometre (10-15m). The atoms themselves are spaced apart 100,000 times this distance.

The new interference scattering technique has set a world record for accuracy in absolute measurements of atomic displacements. (It is also the first measurement of magnetostriction in antiferromagnets.) Most significantly the identification of the origin of ferroelectricty in a multiferroic material is a major step forward in the design of multiferroics for practical applications.

"By revealing the driving mechanism behind multiferroics, which offer so many potential applications, it underlines how experiments designed to understand the fundamental physics of materials can have an impact on the wider world," concludes Dr. Helen Walker who led the work at the ESRF.

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **European Synchrotron Radiation Facility**, via EurekAlert!, a service of AAAS.

Journal Reference:

1. H. C. Walker, F. Fabrizi, L. Paolasini, F. De Bergevin, J. Herrero-Martin, A. T. Boothroyd, D. Prabhakaran, D. F. Mcmorrow. **Femtoscale Magnetically Induced Lattice Distortions in Multiferroic TbMnO3**. *Science*, 2 September 2011: Vol. 333 no. 6047 pp. 1273-1276 DOI: 10.1126/science.1208085

http://www.sciencedaily.com/releases/2011/09/110901142058.htm

Cloud-making: Another human effect on the climate

- 24 August 2011 by **Michael Le Page**
- Magazine issue 2827.

Cloud farmers (image: rans Lemmen/Getty)

IN HIS Gaia hypothesis, James Lovelock famously suggested that living organisms could affect clouds - and he was eventually proved right. Now it seems the effect may be even stronger than we thought. Organic vapours released by organisms such as trees, marine bacteria and livestock appear to play a far more important role in cloud formation than suspected.

"This was a big surprise," says Jasper Kirkby at CERN near Geneva, Switzerland, whose team made the finding. Since our activities have such a huge impact on the biosphere, this hints at a previously unknown way in which humans can affect the climate, he says.

Anything that affects cloud formation can in theory affect climate, because clouds can either reflect or trap the sun's heat depending on conditions. Cloud droplets can form only on particles above 50 nanometres. In much of the atmosphere, dust, smoke and sea-spray provide more than enough of these cloud condensation nuclei, or CCNs.

High in the atmosphere, however, such particles are scarce. Here, cloud formation depends partly on trace gases condensing to form particles just 1 nanometre across, which can then grow large enough to act as CCNs.

Kirkby is part of the CLOUD experiment at CERN to investigate whether cosmic rays influence cloud formation. The team started by looking at the formation of the very small particles - a process called aerosol nucleation - by mimicking atmospheric conditions inside an ultraclean steel "cloud chamber", which Kirkby says is the cleanest ever created. Cleanliness is vital since contaminants can themselves become sites of aerosol nucleation.

Aerosol nucleation is known to require sulphuric acid, but Kirkby's team found that it is not enough by itself at low altitudes - the presence of an additional organic trace vapour is needed (*Nature*, DOI: 10.1038/nature10343). "If there is too little of either component then nucleation will not occur at an appreciable rate in the low atmosphere," says Kirkby. That means the organic component - and thus the role of living organisms - is more important than had been thought, although the full implications are not yet understood.

"If it is significant on a global scale, it might mean that the natural emissions of organics is also important in cloud formation," says Bart Verheggen of the Energy Research Centre of the Netherlands in Petten.

Some physicists think galactic cosmic rays - high-energy particles originating from faraway stars - might affect cloud formation. To test their effect on aerosol nucleation, Kirkby's team fired beams similar to cosmic rays through the chamber and found it increased nucleation between 2 and 10 times. But he points out that an increase in 1 nanometre particles does not necessarily translate into the 50 nanometre CCNs needed for cloud formation.

Other evidence shows that even if cosmic rays do affect the climate, the effect must be small. Changes in the number of cosmic rays hitting the atmosphere due to changes in solar activity cannot explain global warming, as average cosmic ray intensities have been increasing since 1985 even as the world has warmed - the opposite of what should happen if cosmic rays produce climate-cooling clouds.

http://www.newscientist.com/article/mg21128274.900-cloudmaking-another-human-effect-on-the-climate.html

Manipulating Plants' Circadian Clock May Make All-Season Crops Possible

Arabidopsis. (Credit: © Vasiliy Koval / Fotolia)

ScienceDaily (Sep. 1, 2011) — Yale University researchers have identified a key genetic gear that keeps the circadian clock of plants ticking, a finding that could have broad implications for global agriculture.

The research appears in the Sept. 2 issue of the journal *Molecular Cell.*

"Farmers are limited by the seasons, but by understanding the circadian rhythm of plants, which controls basic functions such as photosynthesis and flowering, we might be able to engineer plants that can grow in different seasons and places than is currently possible," said Xing Wang Deng, the Daniel C. Eaton Professor of Molecular, Cellular, and Developmental Biology at Yale and senior author of the paper.

The circadian clock is the internal timekeeper found in almost all organisms that helps synchronize biological processes with day and night. In plants, this clock is crucial for adjusting growth to both time and day and to the seasons.

The clock operates through the cooperative relationship between "morning" genes and "evening" genes. Proteins encoded by the morning genes suppress evening genes at daybreak, but by nightfall levels of these proteins drop and evening genes are activated. Intriguingly, these evening genes are necessary to turn on morning genes completing the 24-hour cycle.

The Yale research solved one of the last remaining mysteries in this process when they identified the gene DET1 as crucial in helping to suppress expression of the evening genes in the circadian cycle.

"Plants that make less DET1 have a faster clock and they take less time to flower," said lead author On Sun Lau, a former Yale graduate student who is now at Stanford University. "Knowing the components of the plant's circadian clock and their roles would assist in the selection or generation of valuable traits in crop and ornamental plants."

Other authors from Yale are Xi Huang, Jae-Hoon Lee, Gang Li and Jean-Benoit Charron, now of McGill University.

The research was funded by the National Institutes of Health and the National Science Foundation. Lau was supported in part by the Croucher Foundation.

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Yale University**.

Journal Reference:

1. On Sun Lau, Xi Huang, Jean-Benoit Charron, Jae-Hoon Lee, Gang Li, Xing Wang Deng. **Interaction of Arabidopsis DET1 with CCA1 and LHY in Mediating Transcriptional Repression in the Plant Circadian Clock**. *Molecular Cell*, 2011; 43 (5): 703-712 DOI: 10.1016/j.molcel.2011.07.013

http://www.sciencedaily.com/releases/2011/09/110901134643.htm

Sparing or Sharing? Protecting Wild Species May Require Growing More Food On Less Land

Farming in India. Researchers collected information on more than 600 species in southwest Ghana and northern India, two parts of the world where demand for agricultural land is putting ever more pressure on wild species. (Credit: © muralinathypr / Fotolia)

ScienceDaily (Sep. 1, 2011) — In parts of the world still rich in biodiversity, separating natural habitats from high-yielding farmland could be a more effective way to conserve wild species than trying to grow crops and conserve nature on the same land, according to a new study published on September 2, 2011 in the journal *Science*.

The study, by researchers at the University of Cambridge and the Royal Society for the Protection of Birds, collected information on more than 600 species in southwest Ghana and northern India, two parts of the world where demand for agricultural land is putting ever more pressure on wild species. The researchers measured crop production as well as the abundances of birds and trees in forests and in various types of farmland.

"Farmland with some retained natural vegetation had more species of birds and trees than high-yielding monocultures of oil palm, rice or wheat but produced far less food energy and profit per hectare," said lead author Dr Ben Phalan from the University of Cambridge. "As well as requiring more land to produce the same amount of food, the 'wildlife-friendly' farmlands were not as wildlife-friendly as they first appeared. Compared with forest, they failed to provide good habitat for the majority of bird and tree species in either region."

The researchers discovered that, under current and future scenarios of food demand, most species would have larger total populations if farming was restricted to the smallest area feasible, while protecting as much natural forest as possible. This was true not just for rare species but for common species as well.

This strategy, called 'land sparing', uses higher yields on existing farmland to spare land for nature (in contrast with 'land sharing', which aims to conserve wild species and grow crops on the same land). Because high-yield farming produced more food from less land, it could be used as part of a strategy to protect larger tracts of natural habitats such as forest.

"It would be nice to think that we could conserve species and produce lots of food, all on the same land," said study author, Dr Malvika Onial from the University of Cambridge. "But our data from Ghana and India show that's not the best option for most species. To produce a given amount of food, it would be better for biodiversity to farm as productively as possible, if that allows more natural habitat to be protected or restored."

"It is critical to note that increasing crop yields would not work in isolation," said study author Professor Andrew Balmford from the University of Cambridge. "Such increases need to be combined with active measures such as national parks and community reserves to protect natural habitats from conversion to farmland. Conservation policy-makers should explore new ways to link protection of natural habitats with efforts to increase food yield per unit area in sustainable ways. Food retailers could perhaps make these linkages a feature of environmentally-friendly food products."

The researchers cautioned, however, that although their findings in Ghana and India are remarkably consistent, they may not hold true everywhere. It is possible that land sparing will be a better strategy in some places and land sharing in others. They advise that further studies in representative parts of the world are needed to determine whether there is a more general pattern.

"Our study does not give uncritical support to large-scale agribusiness over small-scale farming systems," said study author Professor Rhys Green from the Royal Society for the Protection of Birds and the University of Cambridge. "High-yielding organic farming and other systems such as agroforestry can be a useful component of a land sparing strategy and may offer the additional advantage of fewer adverse effects of farming from fertilisers and pesticides. But whatever the farming system, protection of natural habitats will continue to be essential for the conservation of many species."

Story Source:

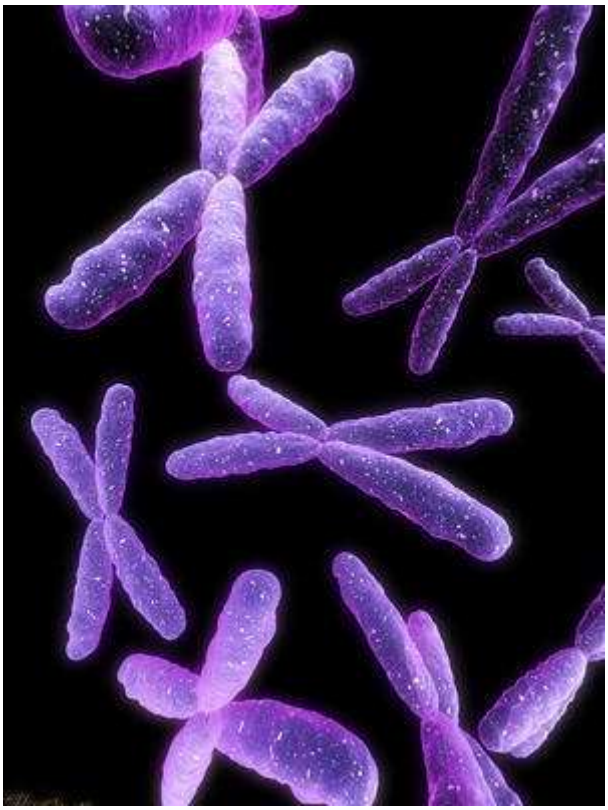
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of Cambridge**, via EurekAlert!, a service of AAAS.

Journal Reference:

1. Ben Phalan, Malvika Onial, Andrew Balmford, Rhys E. Green,. **Reconciling food production and biodiversity conservation: land sharing and land sparing compared**. *Science*, 2 September 2011: Vol. 333 no. 6047 pp. 1289-1291 DOI: 10.1126/science.1208742

http://www.sciencedaily.com/releases/2011/09/110901142102.htm

'Gene Overdose' Causes Extreme Thinness



Artist's rendering of chromosomes. Researchers have identified that duplication of a part of chromosome 16 is associated with being underweight. (Credit: © Sebastian Kaulitzki / Fotolia)

ScienceDaily (Aug. 31, 2011) — Scientists have discovered a genetic cause of extreme thinness for the first time, in a study published August 30 in the journal *Nature*. The research shows that people with extra copies of certain genes are much more likely to be very skinny. In one in 2000 people, part of chromosome 16 is duplicated, making men 23 times and women five times more likely to be underweight.

Each person normally has a copy of each chromosome from each parent, so we have two copies of each gene. But sometimes sections of a chromosome can be duplicated or deleted, resulting in an abnormal 'dosage' of genes.

In a study examining the DNA of over 95,000 people, researchers at Imperial College London and the University of Lausanne have identified that duplication of a part of chromosome 16 is associated with being underweight, defined as a a body mass index below 18.5. Half of all children with the duplication in the study have been diagnosed with a 'failure to thrive', meaning that their rate of weight gain is significantly lower than normal. A quarter of people with the duplication have microcephaly, a condition in which the head and brain are abnormally small, which is associated with neurological defects and shorter life expectancy. Last year, the same researchers discovered that people with a missing copy of these genes are 43 times more likely to be morbidly obese.

Professor Philippe Froguel, from the School of Public Health at Imperial College London, who led the study, said: "The dogma is that we have two copies of each gene, but this isn't really true. The genome is full of

holes where genes are lost, and in other places we have extra copies of genes. In many cases, duplications and deletions have no effect, but occasionally they can lead to disease.

"So far, we have discovered a large number of genetic changes that lead to obesity. It seems that we have plenty of systems that increase appetite since eating is so important -- you can suppress one and nothing happens. This is the first genetic cause of extreme thinness that has been identified.

"One reason this is important is that it shows that failure to thrive in childhood can be genetically driven. If a child is not eating, it's not necessarily the parents' fault.

"It's also the first example of a deletion and a duplication of one part of the genome having opposite effects. At the moment we don't know anything about the genes in this region. If we can work out why gene duplication in this region causes thinness, it might throw up new potential treatments for obesity and appetite disorders. We now plan to sequence these genes and find out what they do, so we can get an idea of which ones are involved in regulating appetite."

The part of chromosome 16 identified in the study contains 28 genes. Duplications in this region have previously been linked with schizophrenia, and deletions with autism.

The study was funded by the Medical Research Council, the Wellcome Trust, and other sources.

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Imperial College London**, via EurekAlert!, a service of AAAS.

Journal Reference:

1. Sébastien Jacquemont et al. **Mirror extreme BMI phenotypes associated with gene dosage at the chromosome 16p11.2 locus**. *Nature*, 2011; DOI: 10.1038/nature10406

http://www.sciencedaily.com/releases/2011/08/110831160038.htm

Instant Expert: HIV Today

- 02 September 2011
- Magazine issue 2828.

More manageable doses are required today (Image: View China/Rex Features)

The development of powerful drug regimens that can virtually eliminate HIV replication is arguably one of medicine's greatest success stories; an HIV infection no longer has to be a death sentence. But infection rates are still breathtakingly high in many parts of Africa, reaching over 15 per cent of adults in countries such as South Africa and Zimbabwe. Now the challenge is to fund drug treatment for all who need it while cutting the number of new infections.

Politics of aids

The early history of AIDS has shaped perception and treatment of today's epidemic in important ways. It emerged among gay men, who were widely regarded as immoral by the homophobic majority in the US. The addition of prostitutes and heroin addicts to the list of high-risk groups did little to increase public sympathy, so at first funding for prevention and care remained scarce.

To reduce discrimination against people with HIV and to try and stop it spreading, activists and many in the public health establishment tried to create a sense of shared risk: the mantra was "Anyone can get HIV". When the epidemic took off among straight people in Africa, the difficulty of confronting the different patterns of sexual relationships became clear. So people working in the HIV industry took the spotlight off the controversial issues of sex and drugs by emphasising the social dimensions of the epidemic. It was packaged as a problem not so much of unprotected sex but of underdevelopment, poverty, gender inequality, human rights and much else.

The strategy certainly brought in more cash: funding for HIV prevention and treatment in developing countries ballooned from under $250 million a year in the early 1990s to some $18 billion last year. Ironically, it also made it harder to spend money where it might be most effective, in programmes that provide clean needles to drug users, or that provide sexual health services to people most at risk.

Governments that didn't want to engage with the messy realities of sex and drugs chose more politically popular approaches, such as stopping transmission from mother to child, care for orphans, and treatment programmes. In the mid-1990s, an estimated 2.5 million people a year became infected with HIV. A decade and a half later we have over 70 times as much cash available for prevention and care, but only a small fraction of it is spent on programmes that directly reduce the likelihood of an infected person passing on body fluids to someone else. Perhaps unsurprisingly, then, this year another 2.5 million people will be infected with HIV worldwide.

Two epidemics

The global HIV epidemic used to be treated as if it were a single entity that played out the same way across the world. It's now clear that sub-Saharan Africa has a different pattern of infections to other countries.

In the west and most of the developing world outside sub-Saharan Africa, HIV remains largely confined to certain groups - namely drug injectors, gay men and prostitutes - in what are sometimes termed "concentrated epidemics". That's because HIV is a hard virus to catch sexually, and people are more likely to pass it on in the first few weeks after infection, when their viral load is highest (see graph). HIV will thus spread fastest through groups where people have unprotected sex with more than one partner in a short period - mainly prostitutes and gay men on the party scene. In most of the world, as a broad generalisation, straight men and women tend to practise serial monogamy.

In the second pattern, common in east and southern Africa and some parts of west Africa and the Caribbean, HIV has spread deep into the general population, in a so-called "generalised epidemic". Infection rates can be about 10 per cent of the straight population or in some areas even higher. That's because in these countries both men and women are more likely to have a small number of concurrent long-term partners with whom they have sex regularly, perhaps because of a legacy of polygamy and freedom of movement for both sexes.

Infection may initially have risen fastest among sex workers and their clients, but those men then had sex with several other regular partners while still highly infectious. Since some of those newly infected women also had multiple partners, HIV was soon carried deep into the general population.

Outside of sub-Saharan Africa, people in high-risk groups do sometimes pass the virus on to partners who don't themselves trade sex or have gay sex. But where serial monogamy is the norm, those people will probably not then have sex with someone else until the early, highly infectious period has passed. So they are less likely to pass the virus to straight partners.

Life-saving drugs

From the time the virus was identified, HIV and AIDS were talked about almost interchangeably, since the first inevitably led to the second, with a time lag of about 10 years. Then in 1995, researchers showed that drug treatment could put the brakes on HIV replication, causing the amount of virus in someone's blood and bodily fluids to plummet to undetectable levels.

The first medicines had nasty side effects, such as nerve damage and severe diarrhoea, and involved complicated dosing regimens of up to 20 pills a day. Nowadays, people start treatment with just one or two tablets a day, and any side-effects are less dire. People who are HIV-positive can stay healthy for several

decades if they scrupulously take their medicines. They seem to have slightly higher rates of osteoporosis, dementia and liver damage, but these problems pale by comparison with full-blown AIDS. Where the drugs are affordable, HIV has been transformed from an inevitably fatal infection to a manageable, life-long condition comparable to diabetes.

But as AIDS - the visible face of HIV - disappears, the incentive to limit sexual partners and use condoms is evaporating. This is probably why new infections are rising among gay men in many western countries.

http://www.newscientist.com/article/mg21128286.100-instant-expert-hiv-today.html?full=true&print=true

Hibernation molecule boosts therapeutic hypothermia

- 01 September 2011
- Magazine issue 2827.

CHILLED-OUT mice could point the way to reduced heart-attack damage in humans.

Therapeutic hypothermia is already used to protect patients suffering injuries that restrict the flow of blood and oxygen to tissues, but cooling is slow and difficult, not least because the body resists it.

In tests on mice in which heart attacks were induced, Cheng Chi Lee at the University of Texas at Austin showed that a biomolecule called 5'-AMP, which helps suppress metabolism in hibernating mammals, could be used to help induce hypothermia and reduce heart tissue damage.

Untreated mice and those given 5'-AMP but artificially kept at normal temperatures suffered greater heart damage. Injected mice experienced a dramatic drop in metabolic rate, meaning they could be cooled faster and more safely than untreated mice (*American Journal of Translational Research*, vol 3, p 351).

"This advances the idea that 5'-AMP could be useful as an adjunct therapy to the body cooling already used to protect hearts from injury after heart attack or cardiac surgery," says Jeremy Pearson of the British Heart Foundation.

http://www.newscientist.com/article/mg21128275.900-hibernation-molecule-boosts-therapeutic-hypothermia.html?full=true&print=true

First Lizard Genome Sequenced: Green Anole Lizard's Genome Sheds Light On Vertebrate Evolution

The green anole lizard (Anolis carolinensis) -- a native of the Southeastern United States -- is the first non-bird species of reptile to have its genome sequenced and assembled. (Credit: Photo by David E. Scott, Savannah River Ecology Laboratory, Aiken, SC, USA)

ScienceDaily (Aug. 31, 2011) — The green anole lizard is an agile and active creature, and so are elements of its genome. This genomic agility and other new clues have emerged from the full sequencing of the lizard's genome and may offer insights into how the genomes of humans, mammals, and their reptilian counterparts have evolved since mammals and reptiles parted ways 320 million years ago. The researchers who completed this sequencing project reported their findings August 31 online in the journal *Nature*.

The green anole lizard (*Anolis carolinensis*) -- a native of the Southeastern United States -- is the first non-bird species of reptile to have its genome sequenced and assembled. Broad researchers have assembled and analyzed more than 20 mammalian genomes -- including those of some of our closest relatives -- but the genetic landscape of reptiles remains relatively unexplored.

"Sometimes you need to be at a certain distance in order to learn about how the human genome evolved," said Jessica Alföldi, co-first author of the paper and a research scientist in the vertebrate genome biology group at the Broad Institute. "You have to look out further than you were looking previously."

Lizards are more closely related to birds -- which are also reptiles -- than to any of the other organisms whose genomes have been sequenced in full. Like mammals, birds and lizards are amniotes, meaning that they are not restricted to laying eggs in water. "People have been sequencing animals from different parts of the vertebrate tree, but lizards had not been previously sampled," said Kerstin Lindblad-Toh, scientific director of vertebrate genome biology at the Broad and senior author of the Nature paper. "This was an important branch to look at."

Four hundred species of anole lizards have fanned out across the islands of the Caribbean, North America, Central America, and South America, making them an appealing model for studying evolution. Although much is known about their biology and behavior, genomic information may be a critical missing piece for understanding how the lizards have become so diverse. "Anoles are rich in ecology and morphology and have just the right amount of diversity to make them interesting yet tractable to study," said Jonathan Losos, an author of the paper, professor at Harvard University, and author of the book Lizards in an Evolutionary Tree: Ecology and Adaptive Radiation of Anoles. "But a big stumbling block in studying them has been that they

have not been great organisms for classical genetic study. The genome is going to revolutionize our ability to study that aspect of their evolutionary diversification."

One of the questions this newly sequenced genome may help resolve has to do with the origin of conserved, non-coding elements in the human genome. These regions do not contain protein-coding genes but are thought to have critical roles since they have remained unchanged for millennia. Scientists wondered where these mysterious elements came from and hypothesized that they may be the relics of transposons -- jumping stretches of DNA that were at one time able to copy and paste themselves throughout the genome. In humans, many of these so called "jumping genes" have lost their jumping ability, but in anole lizards, they continue to hop.

"Anoles have a living library of transposable elements," said Alföldi. The researchers aligned these mobile elements to the human genome, and found that close to 100 of the human genome's non-coding elements are derived from these jumping genes. "In anoles, these transposons are still hopping around, but evolution has used them for its own purposes, turning them into something functional in humans."

In addition to insights into human and mammalian genomes, the anole lizard's genome also offers up clues about how lizard species evolved to populate islands in the Greater Antilles. Much like Darwin's finches, anoles adapted to fill all of the ecological niches the islands have to offer. Some lizards have short legs and can walk along narrow twigs; others are green in color with big toe pads suited for living high up in trees; others are yellow and brown and live in the grass. But unlike the finches, lizards on different islands have independently evolved diverse communities of these twig, canopy, and grass dwelling species -- almost identical lizard species have evolved in parallel on the islands of Hispaniola, Puerto Rico, Cuba, and Jamaica.

"These lizards have been compared to Darwin's finches and in many respects they are similar," said Losos. "They show the workings of natural selection as species adapted to different habitats. But the difference is in the case of the lizards, this evolution has happened four times, once on each of the different islands."

By sampling the genomes of more than 90 species, the researchers were able to make a preliminary map of how these species evolved to colonize the islands.

"This is setting the stage for the research community to be able to look for signatures of adaptation in a very informative and well thought through way," said Lindblad-Toh.

The researchers were also able to create a parts list of proteins found in green anole eggs, which they compared with those found in eggs from chickens and found that both bird and lizard egg genes are evolving rapidly. They also found many genes in the anoles genome associated with color vision, which anoles rely on to identify choice mates (males and females of some species display vividly colored flaps of skin beneath their necks called dewlaps).

"Anoles have extremely good color vision -- some species can even see in the ultraviolet range," said Losos. Other studies have shown that anoles can distinguish between similar colors and patterns. "It's pretty clear that one function of the dewlap is to distinguish one species from others and that they use the dewlap to determine whether another individual is in another species or not."

The researchers performed the first analysis of several other unusual features in the anole genome, including microchromosomes -- tiny chromosomes sometimes found in reptiles, amphibians, and fish but never in mammals. They also found a complete lack of isochores, regions of the genome with high or low concentrations of the nucleotides "G" (guanine) and "C" (cytosine) which give human chromosomes a distinct banding pattern.

Additionally, the team found the sex chromosomes of the lizard -- something that researchers had only been able to hypothesize about before. Like mammals, green anoles appear to have XX and XY chromosomes (unlike birds, in which males have two identical sex chromosomes called ZZ and females have two different ones known as ZW). The lizard's X chromosome turned out to be one of its many microchromosomes.

Each of these insights is the fruit of collaborative efforts among scientists with expertise in the study of proteins, gene family evolution, green anole behavior and biology, computational analysis, and more. "This work represents a partnership between biologists and computational biologists," said Federica Di Palma, a co-first author of the paper and assistant director of the Broad's vertebrate genome biology group. "We were able to leverage all of these views to gain insight into genome evolution in general."

Other researchers who contributed to this work include Manfred Grabherr, Christina Williams, Lesheng Kong, Evan Mauceli, Pamela Russell, Craig B. Lowe, Richard Glor, Jacob D. Jaffe, David A. Ray, Stephane Boissinot, Andrew M. Shedlock, Christopher Botka, Todd A. Castoe, John K. Colbourne, Matthew K. Fujita, Ricardo Godinez Moreno, Boudewijn F. ten Hallers, David Haussler, Andreas Heger, David Heiman, Daniel E. Janes, Jeremy Johnson, Pieter J. de Jong, Maxim Y. Koriabine, Peter Novick, Marcia Lara, Chris L. Organ, Sally E. Peach, Steven Poe, David D. Pollock Kevin de Queiroz, Thomas Sanger, Steve Searle, Jeremy D. Smith, Zachary Smith, Ross Swofford, Jason Turner-Maier, Juli Wade, Sarah Young, Amonida Zadissa, Scott V. Edwards, Travis C. Glenn, Christopher J. Schneider, Eric S. Lander, Matthew Breen, and Chris P. Ponting.

Funding for this work was provided by the National Human Genome Research Institute (NHGRI) with early support for anole genomics from the David and Lucile Packard Foundation. All sequence data was produced by the Genome Sequencing Platform of the Broad Institute.

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Broad Institute of MIT and Harvard**. The original article was written by Haley Bridger.

Journal Reference:

1. Jessica Alföldi, Federica Di Palma, Manfred Grabherr, Christina Williams, Lesheng Kong, Evan Mauceli, Pamela Russell, Craig B. Lowe, Richard E. Glor, Jacob D. Jaffe, David A. Ray, Stephane Boissinot, Andrew M. Shedlock, Christopher Botka, Todd A. Castoe, John K. Colbourne, Matthew K. Fujita, Ricardo Godinez Moreno, Boudewijn F. ten Hallers, David Haussler, Andreas Heger, David Heiman, Daniel E. Janes, Jeremy Johnson, Pieter J. de Jong, Maxim Y. Koriabine, Marcia Lara, Peter A. Novick, Chris L. Organ, Sally E. Peach, Steven Poe, David D. Pollock, Kevin de Queiroz, Thomas Sanger, Steve Searle, Jeremy D. Smith, Zachary Smith, Ross Swofford, Jason Turner-Maier, Juli Wade, Sarah Young, Amonida Zadissa, Scott V. Edwards, Travis C. Glenn, Christopher J. Schneider, Jonathan B. Losos, Eric S. Lander, Matthew Breen, Chris P. Ponting, Kerstin Lindblad-Toh. **The genome of the green anole lizard and a comparative analysis with birds and mammals**. *Nature*, 2011; DOI: 10.1038/nature10390

http://www.sciencedaily.com/releases/2011/08/110831160032.htm

Olympic sculpture is a marvel of mathematics

11:36 31 August 2011
Architecture

Shaoni Bhattacharya, consultant

(Image: Arcelor/Mittal)

"THE engineering is the art, and the art is the engineering." So says Cecil Balmond, structural engineer, designer and artist, who together with Turner prize-winning sculptor Anish Kapoor has created an innovative tower that challenges conventions in engineering and design to commemorate the 2012 Olympic games in London.

Next month, the last piece of red, snaking steel will be placed atop London's newest landmark: the *ArcelorMittal Orbit* in the Olympic Park in Stratford, London. At 115 metres high, the sculpture will be the UK's tallest, towering over the Statue of Liberty. Built by engineers at international firm Arup, the tower is made from 2200 tonnes of steel provided by steel company ArcelorMittal, which is stumping up £19.6 million of the £22.3 million price tag.

Kapoor and Balmond's design was a direct response to a call from London's mayor Boris Johnson for an iconic tower for the games. We thought: what can we do that is different, recalls Balmond, who runs the Balmond Studio in London.

Most towers are the same: vertical, flaring out at the bottom and thinning at the top, says Balmond, who until recently headed up Arup's Advanced Geometry Unit. "What could be different is an orbit," he says. The sculpture follows an orbit, linking with itself for stability. "Like a planetary orbit it goes round and round and round and is stable. So instead of a straight continuous cone, we have an orbit,which each time it passes itself it connects."

To design the tower along these lines, Balmond and Kapoor took two foci in space and made the structure loop continuously round them in a figure of eight motion. They used a computer program to do this, specifying limits at the top and bottom. At the bottom limit, the looping is cut off, leaving the sculpture supported on an inherently stable tripod. "It's very, very stable even though it looks energetic and is not a traditional form," says Balmond.

Adding to this stability, the tower has a swinging steel pendulum, called a "tuned mass damper", which stops the top of the tower wobbling. "The structure is stable but flexible like a tree," says Holger Falter, the lead engineer behind the tower at Arup.

Balmond adds that in most towers gravity acts vertically, but in the *ArcelorMittal Orbit* it acts through the points where the looping steel meets.

Other practical challenges had to be overcome. Falter says mathematics allowed them to calculate wind forces on the tower precisely, and that the tower's spread-out base reduces these.

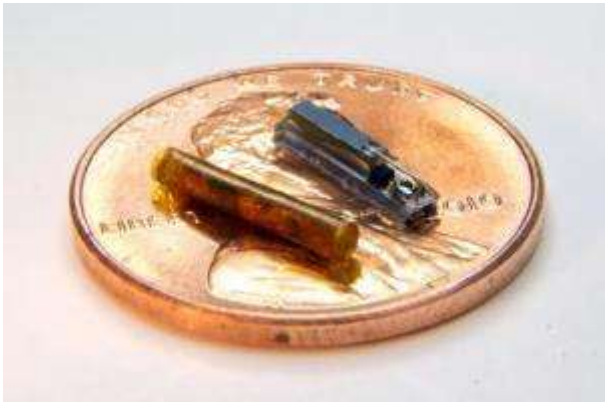
Balmond holds that the artistic and engineering aspects of the tower work together. "There are no compromises on structure and art - they both make the same statement," he says.

The statement is the sculpture's dynamism and energy, which the designers hope will give the visitor a "narrative in space". Like much of Kapoor's work, the *ArcelorMittal Orbit* plays with notions of light and dark, with visitors entering the tower through a sunken black crater to be taken up to the light upper observation decks in a lift.

Balmond knows that not everyone will applaud their creation. "It's primeval. It's not polite. It's strong. People will read things into it. Some will love it. Some will hate it." But he adds: "I hope people will enjoy moving through its narrative."

http://www.newscientist.com/blogs/culturelab/2011/08/olympic-sculpture-is-a-marvel-of-mathematics.html

Tiny Oxygen Generators Boost Effectiveness of Anticancer Treatment



Researchers have created and tested a miniature device, seen here, that can be implanted in tumors to generate oxygen, boosting the killing power of radiation and chemotherapy. The technology is designed to treat solid tumors that are hypoxic at the center, meaning the core contains low oxygen levels. The device (right) fits inside a tube (left) that can then be inserted into a tumor with a biopsy needle. (Credit: Birck Nanotechnology Center, Purdue University)

ScienceDaily (Aug. 31, 2011) — Researchers have created and tested miniature devices that are implanted in tumors to generate oxygen, boosting the killing power of radiation and chemotherapy.

The technology is designed to treat solid tumors that are hypoxic at the center, meaning the core contains low oxygen levels.

"This is not good because radiation therapy needs oxygen to be effective," said Babak Ziaie, a Purdue University professor of electrical and computer engineering and biomedical engineering. "So the hypoxic areas are hard to kill. Pancreatic and cervical cancers are notoriously hypoxic. If you generate oxygen you can increase the effectiveness of radiation therapy and also chemotherapy."

The new "implantable micro oxygen generator" is an electronic device that receives ultrasound signals and uses the energy to generate a small voltage to separate oxygen and hydrogen from water ⏚ a chemical operation called water electrolysis.

"We are putting these devices inside tumors and then exposing the tumors to ultrasound," Ziaie said. "The ultrasound energy powers the device, generating oxygen.

The devices were created at the Birck Nanotechnology Center in the university's Discovery Park. Purdue researchers are working with Song-Chu (Arthur) Ko, an assistant professor of clinical radiation oncology at the Indiana University School of Medicine.

Researchers have tested the devices in pancreatic tumors implanted in mice, showing they generated oxygen and shrunk tumors faster than tumors without the devices. The devices are slightly less than one centimeter long and are inserted into tumors with a hypodermic biopsy needle.

"Most of us have been touched by cancer in one way or another," Ziaie said. "My father is a cancer survivor, and he went through many rounds of very painful chemotherapy. This is a new technology that has the potential to improve the effectiveness of such therapy."

Findings are detailed in a research paper appearing online this month in Transactions on Biomedical Engineering. The paper was written by research assistant professor Teimour Maleki, doctoral students Ning Cao and Seung Hyun Song, Ko and Ziaie.

"The implantable mini oxygen generator project is one of 11 projects the Alfred Mann Institute for Biomedical Development at Purdue University (AMIPurdue) has sponsored," Ziaie said. "AMIPurdue has been instrumental in providing the development funding of roughly $500,000 on this project. And beyond funding, the AMIPurdue team has also helped us with market research, physician feedback, industry input, as well as intellectual property and regulatory strategy. We have been able to accomplish a great deal in a short time due to the collaborative effort with AMIPurdue."

A patent application has been filed for the design.

Future work may focus on redesigning the device to make it more practical for manufacturing and clinical trials.

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Purdue University**.

Journal Reference:

1. T. Maleki, N. Cao, S. Song, C. Kao, S.-C. Ko, B. Ziaie. **An Ultrasonically-Powered Implantable Micro Oxygen Generator (IMOG)**. *IEEE Transactions on Biomedical Engineering*, 2011; DOI: 10.1109/TBME.2011.2163634

http://www.sciencedaily.com/releases/2011/08/110831115940.htm

Photons made to change colour and shape

- Updated 18:42 29 August 2011 by **MacGregor Campbell**
- Magazine issue 2827

How do you want us? (Image: Madmat/Flickr/Getty)

FORGET the X-Men - photons are the true superheroes. Not only do they travel at the universe's fastest possible speed, now they have been made to both change colour and shape-shift. The feat brings the dream of ultrafast quantum computers a step closer.

Photons are waves of electromagnetic energy that come in different wavelengths, or colours. The wave patterns also vary in shape, depending in part on how they came into being. The shape of a photon produced by a laser resembles a bell curve, for example, while a photon emitted spontaneously by an atom when an electron loses energy has a peak that rises quickly and tails off slowly. The shape can affect how a photon interacts in collisions.

Photons normally maintain their size and shape until they are absorbed by matter. Now Matthew Rakher at the National Institute of Standards and Technology in Gaithersburg, Maryland, has made photons behave like shape-shifting chameleons. They piped infrared photons with a wavelength of 1300 nanometres into a crystal, into which they also pumped photons from a 1550-nm-wavelength laser. Each had different shapes.

The crystal acted as a waveguide, channelling the photons to hit each other at a specific angle and place, making them blend together to form photons with a wavelength of 710 nm with the same shape as the laser photons (*Physical Review Letters*, DOI: 10.1103/physrevlett.107.083602).

Such transformations will be crucial for developing networked quantum computers. These replace binary bits with quantum bits, or qubits, which can exist in a multitude of quantum states at once, allowing multiple simultaneous calculations.

Quantum computers could send and store data using photons' quantum properties, such as polarisation, which is a measure of a photon's angular momentum. The problem is that the fibre-optic cables that would transmit the photons between computers operate most efficiently at infrared wavelengths, while quantum-memory devices - made of atoms that would absorb the photons - work best with visible photons of a given shape.

The new work would minimise the data lost in translation, says Rakher. "Our research provides a method to take telecommunications-band single photons and change their wavelength and shape so they can be stored in visible-wavelength quantum memories," he says.

Hayden McGuinness at the University of Oregon in Eugene calls the work "a clever method for tackling two difficult problems".

http://www.newscientist.com/article/mg21128274.700-photons-made-to-change-colour-and-shape.html?full=true&print=true

'Landlubber' Fish Leap for Love When Tide Is Right: Research Sheds Light On How Animal Life First Evolved to Colonize Land

The odd lifestyle of the Pacific leaping blenny (Alticus arnoldorum) has been detailed for the first time in research findings that throw new light on how animal life first evolved to colonize the land. (Credit: Gina Cooke, UNSW)

ScienceDaily (Aug. 31, 2011) — One of the world's strangest animals -- a unique fish that lives on land and can leap large distances despite having no legs -- has a rich and complex social life, a new study has found.

The odd lifestyle of the Pacific leaping blenny (*Alticus arnoldorum*) has been detailed for the first time in research findings that throw new light on how animal life first evolved to colonise the land.

The Pacific leaping blenny is a marine fish yet is terrestrial in all aspects of its daily adult life, eking out a precarious existence in the intertidal zone of rocky shores in Micronesia, according to the study published in the journal *Ethology*, led by Dr Terry Ord, of the UNSW Evolution and Ecology Research Centre.

"This remarkable little fish seems to have made a highly successful transition across the water-land interface, although it is still needs to stay moist to enable it to breathe through its gills and skin," says Dr Ord, who is an evolutionary ecologist with a special interest in animal behaviour.

"Our study showed that life on land for a marine fish is heavily dependent on tide and temperature fluctuations, so much so that almost all activity is restricted to a brief period at mid-tide, the timing of which changes daily. During our field study on Guam we never saw one voluntary return to water. Indeed, they spend much of their time actively avoiding submersion by incoming waves, even when we tried to capture them for study.

"I can tell you they are very hard to catch and are extremely agile on land. They move quickly over complex rocky surfaces using a unique tail-twisting behaviour combined with expanded pectoral and tail fins that let them cling to almost any firm surface. To reach higher ground in a hurry, they can also twist their bodies and flick their tails to leap many times their own body length."

Working with Tonia Hsieh, of Temple University in the US, Dr Ord found that adult blennies shelter in rock crevices at high and low tide, emerging at mid-tide to feed, breed and socialise in surprisingly complex ways -- given their brief window of opportunity.

The researchers discovered that males are territorial and use complex visual displays to warn off rivals and attract mates. Females were seen aggressively defending feeding territory at the start of their breeding season, while males displayed a red-coloured fin and nodded their heads vigorously to attract females to their closely defended rock holes. The team filmed females inspecting these holes before entering with a chosen mate.

Little is known of their breeding and development of the young, but it seems that females lay their eggs in a chosen rock hole then play no further role in parenting, leaving the male to guard the eggs.

"The Pacific leaping blenny offers a unique opportunity to discover in a living animal how a water-land transition has taken place," says Dr Ord.

"We know that our ancient ancestors evolved originally from lobe-finned fish but, today, all such fish are fully aquatic. Within the blenny family, however, are species that are either highly terrestrial, amphibious or entirely aquatic. Remarkably, representatives of all these types can be found on or around Guam, making it a unique evolutionary laboratory."

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of New South Wales**, via EurekAlert!, a service of AAAS.

Journal Reference:

1. Terry J. Ord and S. Tonia Hsieh. **A Highly Social, Land-Dwelling Fish Defends Territories in a Constantly Fluctuating Environment**. *Ethology*, 26 AUG 2011 DOI: 10.1111/j.1439-0310.2011.01949.x

http://www.sciencedaily.com/releases/2011/08/110830102542.htm

CSI: Wildlife — Solving Mysterious Animal Deaths

Carol Meteyer solves cases of mysterious wildlife death using advanced forensic skills to help prosecute people who kill animals in violation of federal law.

By Madeline Bodin

Carol Meteyer uses her scalpel and microscope to investigate mysterious animal deaths. (David Nevala)

Carol Meteyer unfurled the Sandhill crane's gray wings across the steel examination table, and for a moment, the 4-foot-tall bird regained its former majesty. In that instant, the laboratory's windowless cinderblock walls, cement floor and fluorescent lights disappeared. It was easy to imagine the crane's wings cupping the prairie air as it landed in an Oklahoma field, its long gray neck stretched, its red crown the only bright spot in a dun landscape.

FedEx had delivered the crane, along with three others, that morning. The day before, it had stood in a farm field in Oklahoma, its head bowed and its wings limp; 10 other cranes were already dead or showing similar symptoms.

Dead animals arrive at the National Wildlife Health Center in Madison, Wis., almost every day, usually by overnight delivery in plastic coolers. State and federal wildlife biologists from all over the country send carcasses to the lab hoping to solve cases of mysterious animal deaths, to confirm their own diagnoses or to provide evidence in legal cases against an animal's killer. Because it does solve animal murder mysteries through scientific investigation, the center has been called wildlife's own CSI unit. It would be just as accurate, though, to call it a wildlife Centers for Disease Control and Prevention. The CDC also solves deadly

mysteries, but the emphasis there, as at the wildlife health center, is on research, outreach and prevention of needless death.

Slim, blond, dressed in a blue paper gown over hospital scrubs and wearing a surgical mask, the 57-year-old Meteyer could easily pass for one of her fictional crime-solving counterparts, except for the knee-high rubber boots she wears like the veterinarian she is. Gently probing the crane with purple-gloved hands, Meteyer feels swelling in its neck and swabs the bird's feathers with a scrub brush dipped in a detergent-and-antiseptic solution. Then, she sharpens a large knife and slices the crane open from throat to belly, examining its skin and its ribs and snipping off the rib cage with heavy surgical scissors.

The crane's spleen is twice as big as it should be, and it's dark red. "I think we are going to have a diagnosis here," Meteyer says. From the moment she heard "crane" and "farm field," she suspected that the cranes were felled by one of the fungal toxins, known as mycotoxins, that plague peanuts, corn and other crops. When this type of fungus strikes, the crop becomes poisonous, and because it can't be sold, farmers too often leave it standing in the field, creating a fatal attraction for wildlife. The mystery for Meteyer is which mycotoxin is responsible. So far the evidence — the swollen neck, a white-spotted kidney, the enlarged spleen and syrupy bile — points to three different possible perpetrators.

Meteyer drops bits of the crane's heart, spleen and other organs into a jar of formalin, which preserves the tissues until they are sliced and placed on microscope slides for her to examine another day. She cuts open the crane's stomach and with a plastic spoon scoops out what looks like ground peanuts, corn and bits of grass. One of the center's microbiologists will culture the stomach contents to see if a toxic fungus grows. Meteyer hopes that either the culture or the microscope will reveal the culprit.

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Meteyer grew up in Illinois and Iowa, spending her days roaming fields and exploring streams. In second grade, she found a toad with a broken leg and decided that it needed to keep still so it could heal. She buried the toad in a shallow hole. When she dug it out three weeks later, it hopped away.

Becoming a veterinarian was always her dream, but after college at the University of Iowa, she found herself teaching high school science. Afraid that the dream was slipping away, one day she signed up for a class in engineering physics, the only course she could take at night while continuing to teach. Along the way, she spent the savings from her teacher's salary on a horse, a horse that was terrified of trailers. When she began veterinary school at Iowa State University the next school year, she rode the horse 130 miles to its new stable in Ames, bunking with farm families as she traveled.

Still a healer of toads at heart, Meteyer began an exotic animal club at the vet school. As a veterinary intern in California, Meteyer was gentle, concerned with not causing her patients any additional pain and empathizing with their owners' worry. Compared to the emotionally draining work of helping sick animals and their heartbroken owners, Meteyer found her visits to the veterinary pathology lab peaceful. There, she found herself drawn to the pastel-stained world of microscope slides. Meteyer wasn't sure she was doing the right thing by leaving the world of living animals, but each heartrending shift as a relief veterinarian assured her that pathology was the better path.

As a veterinary pathologist, it's possible to spend most of your days diagnosing cancer in cats and dogs. Meteyer considered herself lucky, during her residency in Los Angeles, to work on animals from Marineland of the Pacific and horses from the local racetracks, and to test wild wolves for plague. After her residency, she diagnosed the diseases of chickens and turkeys for the poultry industry at the University of California, Davis, where she occasionally saw animals from Fresno's zoo.

A friend told her about what she was sure would be Meteyer's dream job: a wildlife pathologist at the National Wildlife Health Lab. Meteyer thought it a dream job, too, but turned down the lab's offer because she was eight months pregnant with the first of two daughters. However, the job was still open when her maternity leave was over.

As they grew up, her daughters told their friends that their mom cut up dead things for a living. "They think I'm a sweet nerd," she says. They're now in college.

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Along with three fellow wildlife pathologists at the National Wildlife Health Center, Meteyer defines what is normal in wildlife health across the United States and what new patterns of disease and poisoning require the attention of wildlife managers and researchers. She has helped uncover such patterns in regard to white-nose syndrome in bats, abnormalities in frogs, pharmaceutical poisoning in vultures and countless lesser mysteries. Her tools are a scalpel, wielded in a type of animal autopsy called a necropsy, and a microscope.

"When I look through a microscope, I feel so privileged to have that view," Meteyer says. "I have to communicate that to the people who work with the animal." For Meteyer, that not only means the expected report to the wildlife biologist who asked for the lab's help, but also writing journal articles, preparing field guides and speaking at conferences about her findings.

"She very much gets why she is here: to help the people in the field." says Scott Wright, chief of the center's disease investigations branch and Meteyer's boss. "Still, she makes the most she can out of the science." Although not an academic, Meteyer has been an author or co-author of more than 40 peer-reviewed scientific papers. Wright recently helped promote her to a research-grade position. "Carol has her share of discoveries and is well respected because of her experience," he says.

As Meteyer worked on the crane, two technicians worked at another examination table. They had spread out two dozen blackbirds from the headline-grabbing New Year's Eve "Aflockolypse" in Beebe, Ark. Some 5,000 blackbirds out of a flock of a million died that New Year's Eve, after fireworks exploded near their roost. Shortly afterward, a sample of the dead birds was sent to the center for analysis.

One pathologist performed more than 40 necropsies on the birds, finding a similar pattern of trauma in each one. The pathologist's findings were conclusive but unpopular: The birds were startled and died after flying into buildings and power lines. The lab's other pathologists, including Meteyer, answered phone calls from the media and curiosity seekers. While the media interest had moved on, the center continued to analyze the incident. The technicians were swabbing the birds for an avian cholera test.

This was not the first time the National Wildlife Health Center's investigations had been in the public eye. Spurred by the death of 40,000 ducks from duck plague in South Dakota, the lab has helped unravel the mysteries of West Nile virus, chronic wasting disease in deer, waterfowl poisoning by lead shot and monkeypox virus in exotic pets.

At its founding in 1975, the lab was a part of the U.S. Fish and Wildlife Service, a regulatory agency, and in 1996 became a part of the U.S. Geological Survey, which doesn't have federal regulatory authority. But that doesn't mean the wildlife lab's investigations are toothless. The center houses scientists with expertise in viruses, bacteria, fungi, parasites, biochemistry, ecology, veterinary medicine and pathology, and they investigate violations of federal wildlife laws, including the Endangered Species Act, the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act.

The U.S. Fish and Wildlife Service has its own lab in Ashland, Ore., dedicated to wildlife forensics. Meteyer sees the forensics laboratory's expertise as analyzing animal DNA and identifying animals from body parts in smuggling cases; the Wildlife Health Center's legal role focuses on determining whether the cause of death was natural or from human activity. Meteyer's legal cases have included birds that were poisoned by cyanide at a silver mine and endangered wood storks poisoned by pesticides.

Meteyer was in the first half of her nearly two-decade tenure at the lab when abnormal frogs began arriving from Minnesota, Maine, Wisconsin and Vermont. Some had too many legs or toes, others too few. In some locations, 60 percent of the frogs were deformed. Was the thinning ozone layer zapping the frogs with ultraviolet rays? Were pesticides poisoning them? Would we be next?

Meteyer X-rayed the frogs and found that their bones provided valuable clues. Bones in limbs that had been bitten off by a predator when the frog was an adult looked different than locations where a budding leg had been bitten off a tadpole. True malformations — the frog equivalent of a birth defect — looked different from either of these. She put the frog X-rays together, along with a glossary describing the abnormalities, into the "Field Guide of Malformations in Frogs and Toads," which is still used by researchers deciphering new clusters of frog abnormalities. With good information available about the causes of the frog abnormalities, many of them natural, public panic subsided.

And when white-nose syndrome first struck bats in the Northeast four years ago, Meteyer found herself among only a handful of pathologists who believed the powdery white fungus on the bats' skin was the cause of their death. When she examined microscope slides of the affected bats' wing tissues, she saw that the fungus was penetrating the lower, living layers of skin, and the skin reacted by swelling. It was a clear sign that the fungus was attacking living bats and not an opportunistic infection that came later.

Meteyer was a co-author on the paper that announced the white-nose syndrome fungus. She published the physical description of white-nose syndrome — both what it looks like during a necropsy, and what the bat's tissues look like under a microscope — that is used by other pathologists to diagnose new cases of white-nose syndrome.

But unlike casts of the various CSI shows, the Wildlife Health Center staff can't solve every case in an hour, or even a career. Meteyer is still haunted by a bird syndrome called avian vacuolar myelinopathy. When she first started working at the lab, she received American coots, a ducklike bird, and the occasional bald eagle found on Southern lakes. Some were found dead; others were blind and convulsing. Meteyer identified the distinct brain lesion that identifies the syndrome 17 years ago, and birds with the syndrome are still diagnosed at the lab, usually arriving between Thanksgiving and Groundhog Day. But Meteyer has been unable to isolate the biotoxin, possibly produced by algae, that she believes is responsible.

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About a week after the Sandhill crane necropsy, Meteyer received slides of tissue samples. Looking through the microscope in her office, Meteyer entered a world of pink-, blue- and purple-stained cells. She examined a crane kidney that appeared pale and swollen on the examination table and saw no evidence of kidney disease. That eliminated one of the rarer mycotoxins from the list of suspects. The red spots on one of the cranes' livers were revealed, under the microscope, to be bleeding from damaged blood vessels, not dead tissue with blocked vessels. That crossed another mycotoxin off. The cranes' small blood vessels, however, were a mess, dead and clotted with blood.

The toxics tests and the stomach content cultures all came back negative, so Meteyer had to rely on her own observations and experience as she put together her report. The swelling in the cranes' necks, their internal bleeding and the clots in their small blood vessels all suggested to Meteyer that the cranes died of

trichothecene poisoning. That the cranes were eating peanuts was an important clue. “Peanuts are the usual source for the *Fusarium* fungus,” she says. And *Fusarium* produces trichothecene.

In Oklahoma, the farm field where the dead cranes were found had since been seeded with wheat. During planting, at the request of the biologist who’d sent the cranes for testing, the farmer had plowed the fungus-infested peanuts deeply into the ground, burying the mycotoxin they contained. Back in Madison, Meteyer was excited to hear what had happened. “That is what we are here for,” she said as the case of the poisoned Sandhill cranes came to a close. “It’s what brings meaning and relevance to what we do.”

http://www.miller-mccune.com/science/csi-wildlife-solving-mysterious-animal-deaths-32137/

Panda Poop May Be a Treasure Trove of Microbes for Making Biofuels

New research shows that panda feces contains bacteria with potent effects in breaking down plant material in the way needed to tap biomass as a major new source of biofuels. (Credit: © hotshotsworldwide / Fotolia)

ScienceDaily (Aug. 31, 2011) — Panda feces contains bacteria with potent effects in breaking down plant material in the way needed to tap biomass as a major new source of "biofuels" produced not from corn and other food sources, but from grass, wood chips and crop wastes, scientists reported in Denver at the 242nd National Meeting & Exposition of the American Chemical Society (ACS).

"Who would have guessed that 'panda poop' might help solve one of the major hurdles to producing biofuels, which is optimizing the breakdown of the raw plant materials used to make the fuels?" said study co-author Ashli Brown, Ph.D. "We hope our research will help expand the use of biofuels in the future and help cut dependency on foreign oil. We also hope it will reinforce the importance of wildlife conservation."

Brown pointed out that bacteria from the giant panda are particularly promising for breaking down the super-tough plant material known as lignocellulose in switch grass, corn stalks and wood chips. That advance could speed the development of so-called cellulosic biofuels made from these tough plant materials in a way that doesn't rely on precious food crops such as corn, soybeans and sugar now used for making biofuels, she noted.

Scientists have long known that giant pandas -- like termites and cattle -- have bacteria in their digestive systems to break down the cellulose in plants into nutrients. Bamboo constitutes about 99 percent of the giant panda's diet in the wild. An adult may eat 20-40 pounds of bamboo daily -- leaves stems, shoots and all. Until the energy crunch fostered interest in biofuels, however, scientists never thought to parse out exactly what microbes in the giant panda gastrointestinal system were involved in digestion.

Brown and colleagues, including graduate student Candace Williams, collected and analyzed the fresh feces of a pair of male and female pandas at the Memphis Zoo for over a year. They identified several types of digestive bacteria in the panda feces, including some that are similar to those found in termites, which are renowned for their ability to digest wood.

"Our studies suggest that bacteria species in the panda intestine may be more efficient at breaking down plant materials than termite bacteria and may do so in a way that is better for biofuel manufacturing purposes," said Brown, who is with Mississippi State University.

Based on other studies, Brown estimated that under certain conditions these panda gut bacteria can convert about 95 percent of plant biomass into simple sugars. The bacteria contain enzymes -- highly active substances that speed up chemical reactions -- so powerful that they can eliminate the need for high heat, harsh acids and high pressures currently used in biofuel production processes, she said. Those processes also tend to be time- and energy-intensive, as well as expensive. Panda bacteria could therefore provide a faster, cleaner and less costly way to make biofuels.

Brown is currently trying to identify every intestinal bacterium in the giant panda in order to isolate the most powerful digestive enzymes for biofuel production and other purposes. She noted that scientists could use well-established genetic engineering technology to put the genes that produce those enzymes into yeasts. The yeasts then would produce the enzymes and could be grown on a commercial scale to provide large amounts of enzymes for a biofuel industry.

"The discovery also teaches a lesson about the importance of biodiversity and preserving endangered animals," Brown said, noting that less than 2,500 giant pandas remain in the wild and about 200 are in captivity. "Animals and plants are a major source of medicines and other products that people depend on. When we lose them to extinction, we may lose potential sources of these products."

The U.S. Department of Energy, The Memphis Zoological Society, the Mississippi Corn Promotion Board, and the Southeastern Research Center at Mississippi State provided funding for this study.

Story Source:

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http://www.sciencedaily.com/releases/2011/08/110829131253.htm

Teacher Collaboration Gives Schools Better Results

The world's best school systems depend on teacher collaboration, but the concept has not caught on in the U.S. We found schools where teamwork is making a difference.

By Melinda Burns

At Wilmington Middle School, teachers meet three times a month after school in "learning teams" to home in on what's working or not in the classroom. (Melinda Burns)

Five years ago, Sparks Middle School hit bottom. Its test scores were some of the worst in the district. A chain-link fence was locked after hours to prevent gangs from tagging the open-air hallways. Between classes, members of rival tagging crews would fight.

Word came down to the La Puente, Calif., school from the Los Angeles County Office of Education: We may shut you down if you don't come up with a plan.

Sparks embarked on a makeover. Sherri Franson, the school's new principal, took down the chain-link fence because she thought it made the school look like a jail. She lengthened the school day by 20 minutes, increased the number of periods from six to seven and hired two literacy coaches. Low-scoring students were required to take double periods of math or English. Every student received a "glory binder" and was taught how to take notes.

And Sparks provided something else: more than six hours each week for teachers to learn from each other.

Sparks teachers are required to meet by grade and subject for one period of disciplined collaboration every day. At the beginning of each school year, they pore over the results of the state's standardized tests from the spring. They identify students as "gainers," "stickers" or "sliders," and they assess where their teaching fell short. As the year progresses, they write tests together, compare results, demonstrate lessons and think up

games to engage their students. They visit other classrooms for 15 minutes once a month to learn new strategies. On Thursdays and Fridays, students start classes 75 minutes later so the faculty can talk about instruction first.

"There's just a feeling of team," Franson says. "Teachers can work together even though they don't see eye to eye."

A large body of research shows that mandatory teacher collaboration, sometimes called "professional learning communities," gets results. The world's best school systems foster a culture of sharing what works and what doesn't. In the high-scoring schools of Finland, South Korea and Shanghai, studies show, teachers are not like private emperors in their classrooms; they make their practice public, becoming the "learners of their own teaching." Yet teamwork has fallen out of favor in schools in the United States in recent years — it's hard to do well and easy to cut at budget time.

In this report, *Miller-McCune* looks at two traditional public schools and a network of public charter schools in California that are transforming education, not by firing teachers but by making them accountable to each other. Aspire Public Schools, a nonprofit charter network that relies on "the magic of effective joint lesson planning," is featured in an international report this year as one of the world's 20 "most improved school systems." On a smaller scale, similar practices are quietly getting results at Sparks and Wilmington middle schools. Wilmington pays teachers to attend after-school meetings three times a month with trained "facilitators" to delve into the nitty-gritty of instruction.

Significantly, in these parlous times for public education, teamwork doesn't have to be expensive. In 2008-2009, the most recent year for which the data is available, Sparks spent $4,560 per student — well below the K-12 average of $8,340 for the Hacienda La Puente Unified School District, with more than 74,000 students one of the largest suburban districts in the state.

The demographics at Sparks haven't changed for years: The student body of 500 is poor and Latino. Many parents work in minimum-wage jobs and live in apartments that are federally subsidized. Criminal street gangs operate in the neighborhood, but the school has shed its reputation for tough kids. It's tough in academics now. Sparks algebra scores today are the highest in the district. In the 2009-2010 school year, 64 percent of Sparks students were proficient or advanced in algebra, compared to 34 percent of all students statewide. Seventy percent of Sparks eighth-graders were proficient in science, compared to 54 percent statewide.

A number of students are not yet fluent in English, and the school lags in reading. But there is progress on all fronts, not all of them purely academic. The grounds are newly landscaped and the students raised funds to buy umbrellas for the lunch patio.

"This doesn't look like a ghetto anymore," a student told Franson.

Sparks scored 807 points out of 1,000 on California's Academic Performance Index during the 2009-2010 school year, making it No. 1 on the list of the state's 100 middle schools serving low-income minority children. Last year, Sparks officials conducted 10 tours for visitors from other districts who wanted to learn the secret of their success.

"Every year, the teachers say the single most important thing that's made a difference in student achievement is collaboration," Franson says. "Any other school like us could do the same thing."

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In his 2010 book, *All Systems Go: The Change Imperative for Whole System Reform*, Michael Fullan, a Canadian educational scholar, writes about the U.S. neglect of what he calls "collective capacity," a kind of planned collaboration that he says can turn around schools, districts and even government departments of education. Fullan says it's "the hidden resource we fail to understand and cultivate," even as the U.S. has slipped to 15th and 16th place, respectively, in world rankings of 15-year-olds' reading and math scores.

Back-to-School Basics

For a look at what public schools are doing to repair themselves on the cheap, check out the education stories found in the September-October 2011 issue of *Miller-McCune*, and when they'll be available on Miller-McCune.com:

Great teachers are prized, but there aren't enough of them, Fullan says. "They don't add up, as seen from the stagnant results of the U.S. school system over the past 30 years. Collective capacity is essential because it produces many more quality teachers who operate in concert."

Fullan wrote the introduction for "How the World's Most Improved School Systems Keep Getting Better," a 2011 report by McKinsey & Company, a global management consulting firm, on how school systems around the world get from fair to good, good to great and great to excellent. The report, which the firm paid for itself, is a follow-up to a 2007 McKinsey report on the common attributes of excellent school systems.

From any starting point, the latest report shows, big gains have little to do with doubling or tripling spending on education: It's more important to revise standards and curricula, set up data systems and track student progress, build the technical skills of teachers and principals, pay the faculty well and promote national policy change.

A common thread is built-in teamwork, the report shows. The best teachers become coaches, sharing their skills and shifting the drive for change to the front lines. At Aspire schools, for example, coaches equipped with microphones at the back of classrooms, give real-time feedback to teachers wearing headsets. In South Korea, where schools went from good to great, districts make grants to schools that lead their own research projects, with teachers from other schools as peer reviewers.

The collaborative approach gets high marks from U.S. teacher unions. At Sparks, for example, the Hacienda La Puente Teachers Association helped design the new work schedule. Jane Shults, a seventh-grade social studies teacher and union vice president, says Sparks teachers are happier, more collegial and more creative now. "We're not an island anymore," she says.

At a panel discussion on the McKinsey report late last year in Washington, D.C., with U.S. Secretary Arne Duncan participating, Randi Weingarten, president of the American Federation of Teachers, lamented the reforms "that gain public currency in the United States, whether it's mass firing, closing schools – the kind of toughness that we do here, evaluating teachers based on individual test scores, embarrassing them, things like that." In contrast, Weingarten praised the "sense of a collective responsibility" in the high-performing schools of Hong Kong and Singapore, two countries highlighted in the report.

"There is this culture of collaboration, shared mission, shared engagement, high expectations and working with people, not doing things to people," Weingarten said. "How do we make that the norm in the United States, as opposed to the kind of John Wayne mentality that we seem to relish here?"

The report names only three American educational systems as among "the world's most improved" — Aspire and the Long Beach Unified School District in California; and the Commonwealth of Massachusetts, including Boston's schools. All were chosen because in five or six years, they moved from fair to good, a McKinsey determination based on scores, interviews and school visits.

"The power of collective capacity is that it enables ordinary people to accomplish extraordinary things, for two reasons," Fullan writes in *All Systems Go*. "One is that knowledge about effective practice becomes more widely available and accessible on a daily basis. The second reason is more powerful still — working together generates commitment."

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In a sign of the bad economy, there were 100 applicants, on average, for every open teaching position for this fall at Aspire charters in the Los Angeles area. Candidates who made the first cut were called in and divided into groups of six. They were given student test scores in a subject and told to come up with a plan for closing the achievement gaps. Principals hovered over the applicants as they hashed things out.

"We get their sense of collaboration as a team," says Sarah Ali, principal of the Aspire Antonio Maria Lugo Academy, an elementary school serving poor Latino children in Huntington Park. "We do that first in the interview process because it's such an important part of our work. If people aren't willing to engage that way, we're pretty up-front about saying, 'Maybe this isn't the right place for you.'"

Aspire's 30 schools target low-income minorities in the Bay Area, Central Valley and Los Angeles. The network faces a court challenge for bypassing local school boards in creating some of its charters, but its academic record is not part of the dispute. Aspire has an Academic Performance Index score of 824, the highest in California among districts in poor communities. Some Aspire schools have been shown to accept a lower proportion of minorities, English learners and low-income students than traditional public schools, but these differences don't account for the speed of student improvement at Aspire — three to five times the average for the 2007-2008 school year alone.

What Would Diane Ravitch Say?

Diane Ravitch, the former assistant U.S. secretary of education who initially supported No Child Left Behind, now says the mandate for standardized testing is "part of the sickness of American education." See what she has to say about teacher collaboration:

What Would Diane Ravitch Say?

Aspire leaders can't point to any one thing that makes the difference. Many Aspire students have a longer school day: They average one hour of instruction more than their peers in traditional public schools. They have a longer school year, too, by 10 days. Private donations from the Bill & Melinda Gates Foundation and others — $5 million this year alone — help pay for teacher support, including a sophisticated data system that breaks down individual student test scores and surveys, and is at every teacher's fingertips. And a culture of collaboration permeates the network at all levels.

"It matters that we have a shared mission," says Heather Kirkpatrick, Aspire vice president of education. "It's a ridiculously, painfully self-reflecting organization that asks itself, 'What are we doing well, what aren't we doing well, and what can we do to get better?'"

New teachers, lead teachers and principals attend "boot camps" before school starts. All 30 principals meet monthly to discuss instruction; and twice a year, the leaders attend three-day retreats. Aspire schools get out early one day each week so that teachers can meet for three hours to analyze data or discuss classroom strategies.

At Antonio Maria Lugo, a school that is 100 percent Latino and 93 percent low-income, 75 children were on the waiting list for kindergarten this fall after 22 seats were filled by lottery. During testing time, a typical day begins in the auditorium with all 220 students shouting, "I am calm, I am strong, I am successful!" Year-round, in keeping with Aspire's mantra, "College for Certain," each class chants the cheer of the college its teacher attended. Students wear T-shirts with the names and colors of those colleges, and they walk, not run, through hallways decorated with college pennants. Instead of room numbers, classrooms have names such as "University of Florida" and "UC Davis." The principal's office is "LMU," for Loyola Marymount University, Ali's alma mater.

After the orderly morning ruckus, the rest of the day is all business — quiet classes of students so focused, they don't look up when a visitor walks in. Ali does a daily walk-through and meets with every teacher once a week. Pairs of teachers in the same grade meet weekly for "data talks" to look at test scores. Struggling students get help from six adults — the principal, classroom teacher, lead teacher, after-school teacher, counselor and a "literacy intervention specialist."

Will cheating scandals involving standardized tests fuel a movement to reduce the stakes these exams have on public education in the U.S? See our story on The Real Cheating Scandal of Standardized Tests.

At a data talk at the school one morning last May, a fourth-grade teacher told how one student had been "turning to Jell-O in his chair," seemingly not paying attention, yet had suddenly jumped two levels in reading. Her colleagues snapped their fingers in celebration — a custom at Aspire, along with "warm feedback" (a pat on the back) and "cool feedback" (gentle criticism). That afternoon, the faculty met to discuss a study showing that many immigrant students who are admitted to college have not mastered written academic English, even after completing a K-12 education in the U.S.

At Antonio Maria Lugo, 60 percent are proficient or advanced in English reading, compared to 54 percent statewide; and 78 percent of students are proficient or advanced in math, compared to 56 percent of their peers statewide. The school scored 847 on the state Academic Performance Index in 2009-2010, up from 722 in 2005-2006, its first year of operations.

During the 2009-2010 school year, Antonio Maria Lugo spent $9,788 per pupil, compared to $10,495 in Los Angeles Unified. (Overall, studies show, California charter schools receive 36 percent less in per-pupil funding than traditional schools.) Aspire is nonunion and pays teachers less, on average, than traditional districts do — $48,000 at Antonio Maria Lugo, for example, compared to $67,700 in Los Angeles Unified, which is unionized.

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Studies show that teachers get better when they stop saying, "I taught the lesson, but they didn't get it," and start saying, "I haven't taught until they've learned." Yet the concept of using collective capacity to boost student achievement has not caught on, at least in this country. Fullan estimates that less than 5 percent of U.S. school districts put a premium on it.

Beth Wray, president of Pearson Learning Teams, a Santa-Monica-based unit of Pearson Education North America, a firm specializing in education services, says it's hard for districts to schedule time for teachers to work together and hard for them to protect that time.

"In general, teaching has been a solo activity," Wray says. "What we are hearing in general across the country is that there is a bit of disillusionment with the concept of professional learning communities. They are much more difficult to do well than anyone anticipated. When they're not done well, teachers view them as a waste of time, and they'd rather have an extra planning period."

Bucking the trend, Wilmington Middle School, a high-poverty school near the Port of Los Angeles, has embraced learning teams to break out of the patterns of the past, when teachers blamed kids, parents, society, neighborhoods — anything but their own performance — for their students' low scores. The school is a case study in "Team Up for 21st Century Teaching and Learning," an extensive review of the research on professional learning communities, published in 2010 by the National Commission on Teaching and America's Future, a nonprofit think tank based in Washington, D.C. The review was paid for by the Pearson Foundation.

"The students need a lot of skills," says Wilmington Principal Myrna Brutti, "but this faculty has the drive, and the learning teams have taught them how. They know this is the level where students are. How are we moving them to the next step?"

In 2009-2010, Wilmington's 1,900 students had the best attendance record of any school in the Los Angeles Unified School District. Last spring, Brutti gave the sixth-graders a "Multiplication Madness" field trip to celebrate a school record: 70 percent of them had mastered the times tables. Brutti was hopeful that by this fall, Wilmington would break a score of 700 on the state's Academic Performance Index.

A decade ago, none of Wilmington eighth-graders was proficient in algebra. To boost student achievement, the school hired math and literacy coaches for its teachers, and, in 2006, it joined a district initiative to organize the faculty into learning teams. Pearson was brought in to train teacher "facilitators" on how to guide the teams in planning, executing and analyzing classroom lessons. By 2010, 39 percent of Wilmington's eighth-graders were proficient or advanced in algebra.

"We went from complaining about what students can't do to deep discussions about what strategies we do find success with," says Diana Zarro-Martinez, who coordinates test score data for Wilmington's learning teams. "We are beginning to see a shift in the culture of our school. The conversations have changed from what our students can't do to what our students can do."

At their peak in 2009, Pearson learning teams were operating in 125 schools in Los Angeles Unified. Today, because of budget cuts, only 29 schools are still using the program. Wilmington's teachers meet three times a month for about 45 minutes in 18 learning teams, led by a peer who keeps them on track. Teams of administrators and coaches get together once a week. Wilmington spends $60,000 on the program yearly: half for Pearson and half for staff overtime.

"Collaboration is the mechanism by which we have found that teaching practice changes," Pearson's Wray says. "For us, the best way to improve teachers is to improve their judgment. You cannot teach them everything to do in every situation. What we emphasize is to take that next step and talk about what it was in your teaching that contributed to a student's understanding or lack of understanding."

On one afternoon after school last May, a team of seventh-grade math teachers at Wilmington was trying to figure out why students were having trouble with the Pythagorean theorem, which is "the square of the hypotenuse is equal to the sum of the squares of the other two sides" and applies only to right triangles. The

teachers reported that their students could plug numbers into the equation $a^2+b^2=c^2$ but were mechanically and incorrectly applying it to triangles of all shapes.

“Everything feels like a rush with so many standards to cover,” one teacher said. “It’s just memorizing. They’re not really thinking. It would take two or three days for them to grasp this.”

Brutti, who regularly checks in on these meetings, suggested talking about a real-life right triangle such as a crane and drop ball. Someone else thought of a ladder propped against a wall, and the group agreed to use such examples in their warm-up reviews. All classes at Wilmington are structured on a “me do, we do, you do” plan, with a warm-up, introduction, interaction with students, time for students to work independently and a re-teaching of the lesson.

“The Pythagorean theorem is used ad nauseam in geometry,” Zarro-Martinez said. “It’s something the students have to have mastery of. If we don’t use real-life examples right away, we’re going to lose them.”

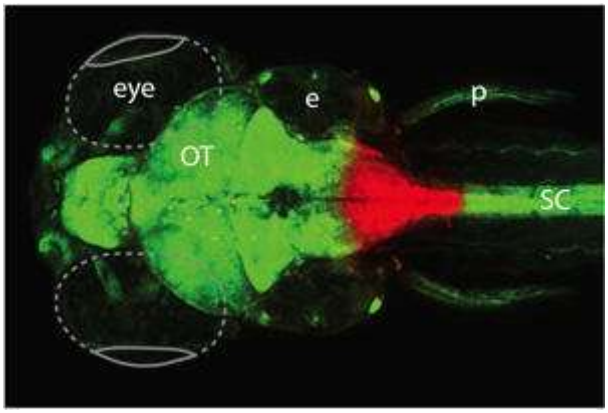
After the meeting, Sandra Martinez, a seventh-grade math teacher, said teamwork made all the difference in what can be a very stressful job. It is draining, she said, to teach 130 students every day, including “the ones who can make you miserable.” The support from colleagues, the chance to learn on the job and the satisfaction of “seeing the bar going up” — all this makes her work easier and more fun, Martinez said.

“I’m so comfortable here,” she said. “My group is really good. We follow the same strategies and pretty much are on the same lesson at the same time. We even do a script and quote what we’re going to say. If it works for our audience, we keep it.

“I don’t believe anything will change in our profession until we get teachers who want to be teachers. If you are truly committed to this profession, if you want to be stimulated and move forward, then collaboration is what you do.”

http://www.miller-mccune.com/education/teacher-collaboration-gives-schools-better-results-34270/

How the Brain Stores Information for Short Periods of Time



The cells of several neural circuits store information by maintaining a persistent level of activity: A short-lived stimulus triggers the activity of neurons, and this activity is then maintained for several seconds. (Credit: Image courtesy of Albert-Ludwigs-Universität Freiburg)

ScienceDaily (Aug. 31, 2011) — Freiburg biologist Dr. Aristides Arrenberg and his American colleagues studied mechanisms used by the brain to store information for a short period of time. The cells of several neural circuits store information by maintaining a persistent level of activity: A short-lived stimulus triggers the activity of neurons, and this activity is then maintained for several seconds. The mechanisms of this information storage have not yet been sufficiently described, although this phenomenon occurs in very many areas of the brain.

The authors of the study, now published in the journal *Nature Neuroscience*, investigated the persistent activity in a hindbrain circuit responsible for eye movements in zebrafish larvae. This circuit, the so-called oculomotor system, gives the command for rapid eye movement by way of special nerve cells that produce a short-lived succession of action potentials. On the one hand, this "burst of fire" reaches the neurons responsible for movement in the eyes and triggers a "saccade," a rapid movement of the eye. On the other hand, it is also transmitted to a second cell population, the so-called neural integrator for eye movements, where the speed signal is integrated mathematically and a position signal is created. This signal is then transmitted to the motor neurons, thus producing -- in fish as well as in humans -- a stable eye position following the rapid eye movement. The neural integrator keeps up this signal for several seconds, until a new saccade is initiated.

The persistent activity in the neural integrator for eye positions is never perfect, as the eyes gradually drift back to their point of rest after a saccade. The authors thus had the possibility of measuring the dynamics of the system during spontaneous eye movements in the dark and testing the model without the measurements being distorted by saccade commands or visual feedback.

The authors discovered that, contrary to previous belief, the cells of the neural integrator for eye movements do not constitute a homogeneous population and that existing models for explaining persistent activity in the oculomotor system will have to be reconsidered. The scientists demonstrated that the integrator neurons do not posses a uniform dynamics and that the neurons are distributed in the hindbrain with the help of their integrator time constants.

These findings provide new evidence on the organization and functioning of circuits with persistent activity and suggest a potential explanation for their low susceptibility to failure. The study is an important milestone in the quest of network neuroscience to explain the functioning of local circuits and thus close the gap between the functioning of a single neuron and the production of behavior.

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Albert-Ludwigs-Universität Freiburg**.

Journal Reference:

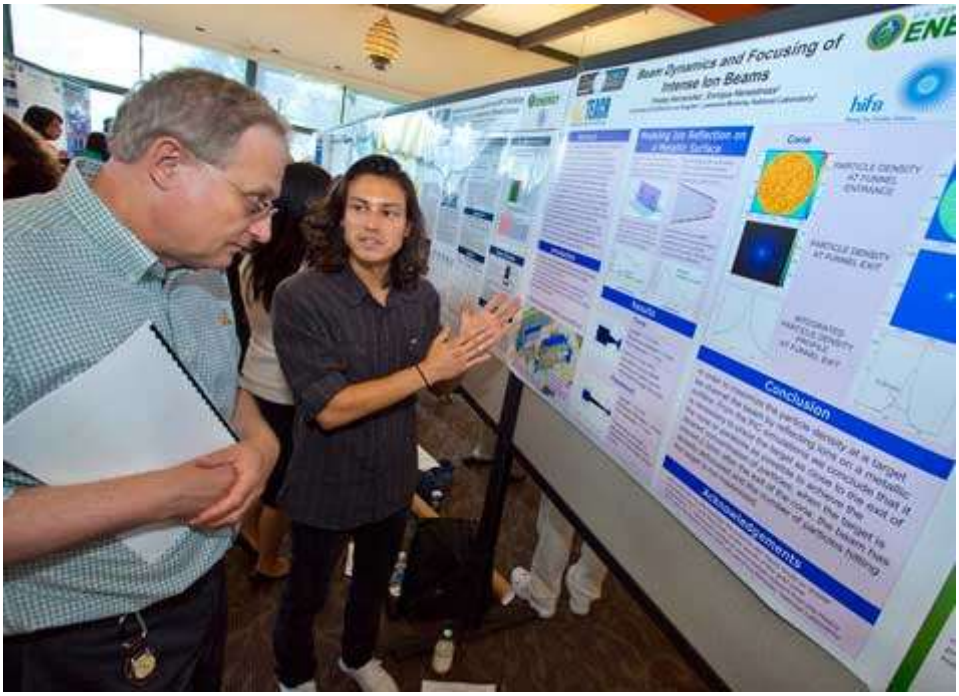
1. Andrew Miri, Kayvon Daie, Aristides B Arrenberg, Herwig Baier, Emre Aksay, David W Tank. **Spatial gradients and multidimensional dynamics in a neural integrator circuit**. *Nature Neuroscience*, 2011; DOI: 10.1038/nn.2888

http://www.sciencedaily.com/releases/2011/08/110824093926.htm

Science Posters Given a New Life Online

A cool new project dubbed Skolr promises to spread the latest science farther and faster by bringing science's ubiquitous poster sessions online.

By James Badham



Pictured, a "poster session" at The Lawrence Berkeley National Laboratory in 2009. A new project, dubbed Skolr, hopes to gather these kinds of posters found at conferences and workshops around the world and archive them in a searchable database. (Lawrence Berkeley National Laboratory)

Anyone who has spent time in academia or attended a scientific conference has seen them — the big plastic-laminated posters that are an indispensable element of science communication.

"Posters are a mass of good information," says Bruce Caron, a social anthropologist and the founder and executive director of the New Media Studio, a nonprofit that uses emerging multimedia technologies to explore the human environment. "They are an entire website, blog or Powerpoint put together on one page by people who are actively involved in research. They're a succinct representation of the most current information available."

Science posters are produced in great numbers. James Frew, a professor of geo-informatics at the University of California, Santa Barbara, calculates that roughly 250,000 posters are presented at academic professional meetings each year in the U.S. alone, representing some 4,000 person-years of production work. A single large academic meeting may have up to 10,000 posters.

But for all that work, the lifespan of the typical science poster is not much longer than that of a housefly, Caron says: "They are printed at the last minute, carried to the conference, presented for a few hours and then thrown away or put up on a back wall of a lab somewhere."

After a January poster event at a meeting of the Federation of Earth Science Information Partners, a group that seeks to improve access to, and uses of, Earth-science data, Caron had a realization. "Poster sessions are obligatory for many disciplines, but the inherent value of a poster is poorly served by a poster event," he says. "I thought we should capture the posters as PDF files, pop them into an archive, capture the abstract, add key words to make them easier to find, and make them available for people to see."

He presented the idea to Josh Greenberg, program manager at the Alfred P. Sloan Foundation, which has funded digital libraries and other projects related to the storage and accessibility of digital information.

"We started talking about how posters have greater value the more visible they are — particularly in a global sense," he recalls. "Say you're an ocean scientist in Africa and you can't make it to the annual American Geophysical Union meeting [one of the largest scientific conferences in the U.S.]. A searchable online database would allow you to browse the poster session and maybe find something valuable that you would not otherwise see."

In April, the Sloan Foundation provided grant funding for a pilot project called Skolr. The unusual spelling of what would be pronounced "scholar," Caron explains, is intended to enhance visibility to Web search engines. The program is being built using open-source software and will be field-tested at the FESIP meeting this summer. The project is receiving support from the New Media Studio, as well as the Carsey-Wolf Center for media studies at UCSB and DigitalOcean, a software platform designed to help scientists work more effectively together and with educators and policy makers.

It will work simply. At registration, presenters will be given a Web URL for poster registration. They'll then sign up, enter their poster abstract, the title, and the names of the authors and upload the poster as a PDF. Some keyword tagging will be added to enhance searchability, and the uploaded data will complement the physical display of the posters for that meeting. Posters captured by the system will be arranged by collection, associated with particular meetings.

Caron sees several benefits.

"It fits in to supporting digital organizations and other organizations with a social-media platform that allows people to share what they couldn't share before," he says. "It adds value to the meeting and to the hosting organization. It makes the posters easier to find, so the presenter gets more interest. Then you take that public, and that meeting has more value for the academy because you're exposing a tableau of current research that was obscured before."

Then there are the opportunities for enhancing interdisciplinary collaboration, a particular interest in the Earth sciences.

"What if there were a hundred meetings of various disciplines that all contributed posters to a searchable collection?" Caron posits. "You could start finding the crosscutting research connections between disciplines, even though people aren't in the same room, at the same meeting, or even in the same area of research. You can imagine an ocean-science researcher who has a project on a marine protected area in Hawaii being able to connect with a poster about the history of colonization on that island. It's a way to provide a larger purview of the activity of doing science. Or imagine you are a person who has a DigitalOcean profile, where you've created a map of your research region of interest, and every time a poster is created somewhere in the world that has content relevant to that, you receive an announcement on your Digital Oceans home page."

But while the software will extend the posters' life indefinitely, Caron doesn't want to alter what he calls the "quintessentially ephemeral nature" of posters.

"We have no intention of changing that," he says. "In other words, just because a poster is archived in a database, we don't want to say that it is now a 'publication.' It's still a poster. So in the software, we have given the presenter the ability to mark the poster as 'superseded,' meaning that the snapshot it represents is not current and may have been superseded by more recent findings. It's a snapshot in time. And people will also be able to remove a poster from the system."

http://www.miller-mccune.com/science/science-posters-given-a-new-life-online-34066/

Tropical Coral Could Be Used to Create Novel Sunscreens for Human Use, Say Scientists

Researchers at King's College London have discovered how coral produces natural sunscreen compounds to protect itself from damaging UV rays, leading scientists to believe these compounds could form the basis of a new type of sunscreen for humans. This image was taken during a trip to the Great Barrier Reef to collect coral samples for analysis (Credit: Australian Institute for Marine Science and King's College London)

ScienceDaily (Aug. 31, 2011) — Researchers at King's College London have discovered how coral produces natural sunscreen compounds to protect itself from damaging UV rays, leading scientists to believe these compounds could form the basis of a new type of sunscreen for humans.

The team has begun to uncover the genetic and biochemical processes behind how these compounds are produced and eventually hope to recreate them synthetically in the laboratory for use in developing sun protection.

This month, as part of the three-year project funded by the Biotechnology and Biological Sciences Research Council (BBSRC), the King's team collected coral samples for analysis from the Great Barrier Reef, a collaboration with Dr Walter Dunlap from the Australian Institute for Marine Science and Prof Malcolm Shick from the University of Maine USA.

Coral is an animal which has a unique symbiotic partnership with algae that lives inside it -- the algae use photosynthesis to make food for the coral and the coral waste products are used by the algae for photosynthesis. Because photosynthesis needs sunlight to work, corals must live in shallow water, which means they are vulnerable to sunburn.

Dr Paul Long, Senior Lecturer from the Institute of Pharmaceutical Science at King's College London, who is leading the project, said: 'We already knew that coral and some algae can protect themselves from the harsh UV rays in tropical climates by producing their own sunscreens but, until now, we didn't know how.

'What we have found is that the algae living within the coral makes a compound that we think is transported to the coral, which then modifies it into a sunscreen for the benefit of both the coral and the algae.

'Not only does this protect them both from UV damage, but we have seen that fish that feed on the coral also benefit from this sunscreen protection, so it is clearly passed up the food chain.

'This led us to believe that if we can determine how this compound is created and passed on, we could biosynthetically develop it in the laboratory to create a sunscreen for human use, perhaps in the form of a tablet, which would work in a similar way.

'We are very close to being able to reproduce this compound in the lab, and if all goes well we would expect to test it within the next two years.'

A long-term goal of the King's study is to look at whether these processes could also be used for developing sustainable agriculture in the Third World, as these natural sunscreen compounds found in coral could be used to produce UV-tolerant crop plants capable of withstanding harsh tropical UV light.

'The part algae play in protecting itself and coral against UV is thought to be a biochemical pathway called the shikimate pathway, found only in microbes and plants. If we could take the part of the pathway that the coral generates, and put this into plants, we could potentially also utilise their shikimate pathway to make these natural sunscreens,' said Dr Long.

'If we do this in crop plants that have been bred in temperate climates for high yield, but that at present would not grow in the tropics because of high exposure to sunlight, this could be a way of providing a sustainable nutrient-rich food source, particularly in need for Third World economies,' he concluded.

Not only has the study revealed the potential of the coral's compound to protect both humans and crops from the sun, but Dr Long's team is also looking for clues as to how climate change is leading to coral 'bleaching', which can lead to coral death.

Bleaching occurs when a rise in sea temperature (by 2-3 degrees more than the summer average) means the algae is lost from the coral tissues, and if the relationship between algae and coral is not re-established, the coral may die. In 1998, world-wide temperature anomalies resulted in a global bleaching event causing major coral mortality on 16 percent of the world's coral reefs. As coral reefs provide a habitat for many forms of sea life, this can lead to significant loss.

Following the recent collection of samples from the Great Barrier Reef, the King's team is looking at the genetic and biochemical changes that occur when coral is exposed to light at higher water temperatures. It is thought that this study will contribute vital knowledge for management and conservation of reef biodiversity in the context of global warming.

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **King's College London**, via EurekAlert!, a service of AAAS.

http://www.sciencedaily.com/releases/2011/08/110830213627.htm

Science

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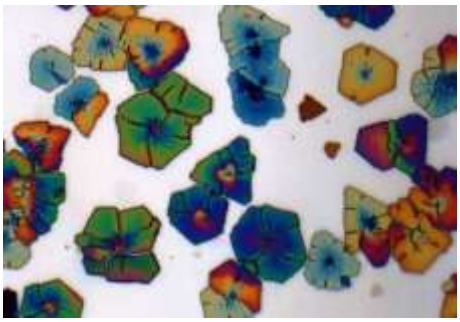
Toxicology of the Tiny

The race to know how nanoparticles affect living things is on, even as the use of those particles is increasing exponentially.

By James Badham



The usefulness of engineered nanoparticles is tempered by a growing body of evidence that suggests some of them may be dangerous to living organisms. (victorpuntes / flickr.com)

Already incorporated into consumer products ranging from baseball bats and clothing to sunscreens and toothpaste, engineered nanoparticles — ENPs — hold great promise in such areas as energy, pollution remediation, medicine and materials science. The nanotechnology industry is projected to be worth $1 trillion by 2015.

It is all made possible by the peculiar properties of nanoparticles, which are defined as having at least one dimension measuring 100 nanometers or less (a nanometer being one-billionth of a meter, or about one one-hundred-thousandth the width of a human hair).

As the number of new nanoparticles rapidly increases, they likely will be released in greater number and diversity into the environment — when the particles are fabricated, during the manufacture of nano-enabled products, throughout the useful life of those products, and at end of life as they find their way into landfills, incinerators and, potentially, soil, water and air.

"The environment is not just a destination for nanoparticles; it transforms them," says microbiologist Patricia Holden. "Pollutants move and change, with possible direct effects on the quality of water, food and air. These environmental concerns are human concerns."

Special Effects

Holden, a professor of microbiology at the Bren School of Environmental Science & Management at the University of California, Santa Barbara, and a lead scientist at the UC Center for Environmental Implications of Nanotechnology, was principal investigator on one study that provided evidence for what Holden refers to as a "nanoparticle effect" — a substance having increased toxicity at the nanoscale than it has in bulk form.

In Holden's study, she exposed bacteria to cadmium ions — well known as a toxin — and cadmium nanoparticles (also known as quantum dots). Using electron microscopy to compare their toxicity, she found that at low concentrations, cadmium ions and ENPs similarly inhibited bacterial growth, but at higher

concentrations, ENPs were more toxic than cadmium ions. Further, while the quantum dots were highly reactive outside the cells, upon entering the cells they became even more reactive and destructive.

While the ions gathered at the outer edge of the membrane and remained there, leaving the cell intact, the ENPs entered the cell and accumulated, reaching concentrations far in excess of those outside the cells and destroying the cellular structure.

"We don't expect bacteria to readily take up engineered nanomaterials because they are too large to pass through the membrane," explains Holden. "But quantum dots damaged the membranes, enabling the particles to pass into the cells, where they were potent toxicants. Now that we know these nanoparticles have a specific and profound effect — a 'nanoparticle effect' — on bacteria, our next goal is to determine why.

"Understanding that can make it possible to 'design out' negative effects, which is key to the environmentally safe use of nanomaterials."

With nanotechnology itself a relatively young science, research on nanotoxicology is even younger. Nonetheless, according to Kristen Kulinowski, director of the International Council on Nanotechology at Rice University, roughly 3,600 papers dealing with some aspect of nanotoxicology have been published to date.

Scientists know quite a bit about ENPs' unique characteristics and abilities, and, according to Kulinowski, "We have pretty significant control over them, so there's enormous flexibility in what we can make." But they know less about questions such as whether and to what degree individual particles are toxic, why and under what conditions and concentrations toxicity occurs, and how long nanoparticles endure in the environment.

"Do bacteria break them down, or do ENPs persist, perhaps as toxicants to the bacteria that would otherwise break them down?" asks Holden. "Nanoparticles exist in nature, but we are making a lot more of them than occur naturally, and we are therefore enabling a level of dispersal that also would not occur naturally."

"Scale-up is accelerating," says Kulinowski, "but not necessarily in terms of new types of nanoparticles. And I cannot point you to a source that has an authoritative number for the total amount of nanoparticles that are out there. But the real question is, 'However many are out there, is that a problem? Are we creating enough of these materials to get into the environment?'"

And what happens if they do enter the environment? The race is on to find out.

Trojan Horses

"The field is changing so rapidly and the landscape of different particles is nearly infinite," says Holden, "We need to rationally but rapidly approach this new field to deliver guidance into the future for environmentally responsible synthesis of nanoparticles."

To that end, several other research groups have also conducted experiments designed to assess ENP toxicity to cells. A common theme among the various efforts is their examination of what has been called the "nano Trojan horse," a process by which nanoparticles "smuggle" toxic ions into cells by defeating cellular defenses that prevent the ions from entering on their own.

A group in Switzerland compared the toxicity of seven industrially important nanoparticles with that of the non-nano forms of the same materials.

One of their findings concerned uncoated iron oxide, which, the researchers noted in their paper, "has been repeatedly proposed for medical treatments such as magnetic drug targeting systems or as a contrast agent in

magnetic resonance imaging." For this presumably safe item they found an ENP-specific toxicological mechanism.

Another group studying the effects of silver nanoparticles on bacteria at the University of Missouri found that the ENPs seemed to alter or inhibit certain defense functions that protect organisms from toxicants. The authors suggest that the particles may act by "directly reacting with the cell membrane to allow a large number of the silver atoms to attack or easily enter the cells."

They add, "The mechanisms by which silver nanoparticles kill microorganisms are … largely unknown, and the mode of antimicrobial action by nanosilver is not clear." The group found evidence that particles having dimensions of less than 10 nanometers "may enter the cell directly to inhibit microbial growth."

"Particularly with respect to silver," says Kulinowski, "there is some thinking that nanoparticles are acting as reservoirs for silver ions, and most organisms can't evolve enough defense to protect themselves from the ions. The nanoparticle may be the ideal delivery vehicle. Or nanoparticles may be using a different mechanism to act on cells than ions do."

While killing "microbes" is often seen as a positive, these experiments are to test the toxicity of ENPs on living organisms; bacteria or microbes are a good starting point because they are reasonably simple. The thinking is that if they have such a profound effect on these single-cell organisms, what will they do to a complex organism?

How nanoparticles behave in a liquid is another important aspect of these recent projects. Holden explains that the toxicity in nanoparticles engineered from toxic metals may not always be a novel new threat by the particles but a simple outcome of dissolution — that is, toxic levels of free ions are released when the nanoparticles dissolve.

This was borne out at the Centre for Environmental Contaminants Research in Australia, where scientists found that the toxicity that zinc oxide nanoparticles had for freshwater algae, bacteria and crustaceans resulted mainly from the organisms' exposure to dissolved zinc.

Similarly, dissolved silver was determined to be the cause of interrupted photosynthesis in freshwater algae exposed to silver nanoparticles. And in a study in South Korea, both silver nanoparticles and dissolved silver were shown to impede the reproductive potential of the nematode C. elegans, but the silver nanoparticles had a more potent effect and were observed to localize near the uterus.

Similarly, silver nanoparticles inhibited the functions of nitrifying bacteria more than dissolved silver did. And finally, one other study found that nanoparticulate iron was fatal to E. coli bacteria while dissolved forms of iron were not.

Still, in some cases the nanoparticles themselves have been shown to be toxic. A group of British researchers, for instance, observed that carbon nanotubes, among the most common form of ENPs, caused lung lesions in rats more quickly than asbestos did.

Too Early or Too Late

Although these findings share a common thread — identifying enhanced toxicity in the nanoparticle form of the substances under study — Kulinowski cautions that it is too early to make any generalized statements beyond saying that "some nanoparticles behave this way in some circumstances. We're all still struggling to understand precise mechanisms by which nanoparticles may cause harm to living organisms."

Still, she says, given the rapid growth of the industry and the many remaining questions concerning nanoparticle toxicology, "It is a legitimate concern as to whether potentially dangerous nanoparticles are getting into the environment while scientists try to figure out the mechanisms of any toxicological effects they may have."

Scientists may lack answers to many finer points of nanoparticle toxicity, but they do know that the environmental concerns derived from the same characteristics that may make nanoparticles instrumental in breakthrough technologies.

For instance, ENPs' extremely high ratio of surface area to volume significantly enhances their ability to bond to and react with other materials. Further, a substance that is insoluble as bulk material may become soluble as an ENP, enabling it to pass through a membrane, and non-conductive materials may become conductive in their nanoparticulate form.

Also, nanoparticles are so small that they can be inhaled easily, passing into the bloodstream and accumulating in organs. Healthy skin is thought to prevent the particles from entering the body, but the findings are not conclusive and, according to Holden, are the result of experiments conducted on skin that is not being stretched (as it is when a body or limb is bent or twisted). Some nanoparticles have shown a disturbing ability to pass through the olfactory nerve into the brain, evading the blood-brain barrier.

Despite all these characteristics, nanoparticles remain unregulated, and products incorporating them — currently numbering more than a thousand, according to the Project on Emerging Nanotechnologies — do not have to undergo any special testing for safety before being introduced into the marketplace.

"Regulation always lags behind commercialization, and that's true here. There are no nanospecific regulations on the books," says Kulinowski, adding, "The FDA doesn't regulate particles, it regulates products."

She explains that the Consumer Product Safety Commission has no pre-market approval required for nano-enabled products. The U.S. Environmental Protection Agency had a voluntary reporting program in which companies were invited to come forward with nano-enabled products and tell how they're used, but, says Kulinowski, "Not many signed up, so now they're going back to maybe being more formal with this."

Meanwhile, the International Organization for Standardization is working to produce a set of nanoparticle standards.

Wanted: Standards

The search for answers is further complicated because the field of nanotoxicology is so new that standards, benchmarks and research protocols have not yet been established.

"We have lots of papers but it's difficult to tease out generalizable principles," Kulinowski says. One reason is that "protocols are different for different research projects. People are actually doing things like sending nanoparticles around the world and then having the same test conducted to see if perhaps the water is different in Japan and that is what's causing things to turn out differently there than in California. To try to establish protocols, we need a lot more of that kind of work."

Furthermore, she says, much of the early nanotoxicology work "will have to be re-evaluated and reported with better characterization," such as whether particles being tested were crystalline or amorphous, what medium they were tested in and whether they are coated or not.

And some of the groundwork laid so far is unstable. For instance, Kulinowski explains, researchers found that carbon nanotubes interact with dye molecules used in marking and "totally mess up the results, generating false positives or negatives."

There are also issues with measuring the dose that organisms are receiving in experiments.

"When you're dealing with chemicals as toxicants, you measure molarity, or chemical concentration," she says. "But there's no 'right' way to go about it for nanoparticles. Should we measure particle size, number of surfaces on a particle, surface area, or what's on the surface, which may be coated, or cloaked, with other materials? There is no consensus on what the measurements of dose should be."

What there is, however, is agreement that the race to understand nanotoxicology is on — and important.

"The establishment of principles and test procedures to ensure safe manufacture and use of nanomaterials in the marketplace is urgently required and achievable," Andre Nel and three co-authors wrote in 2006 in the journal Science. Nel is chief of the Division of NanoMedicine at the California NanoSystems Institute, director of Medicine at the David Geffen School of Medicine at UCLA, and director of UC CEIN.

"The problem right now is that we don't have the data to know, say, how much titanium dioxide is getting into a river bed and the effect it is having on aquatic life," says Kulinowski. "What we have is knowledge that it shouldn't get into the water because it can lead to bad outcomes. We need source data; we need to understand use and potential exposure in environments. We need to be able to establish acceptable levels of exposure."

"There is not yet a paradigm," says UCSB's Holden, who uses the accumulated body of knowledge on the toxicology of oil products as a parallel. "Oil is essentially a soup of all kinds of materials and compounds, but we have identified and studied the characteristics and toxicity of the various petroleum constituents enough to be able to make some general statements," she says. "We don't have this knowledge for nanoparticles."

Given the challenges to writing the complete book on nanotoxicology, Kulinowski finds hope in the rapidly growing awareness and broadening scientific discussion of the subject.

"We have come an enormous way from 2000 and 2001, the bad old days when people would say, 'Oh, we can't talk about that,'" she says. "Now we have whole centers focused on the risk side. The conversation is mainstream. There are a lot of very smart people working on this now, and we can articulate the questions so that scientists know what they want to find out when they go into the lab.

"The new mantra is: 'Safety by design,'" she continues. "So you figure out how to neutralize the toxicity of a nanoparticle before it gets into the water-treatment plant. You find out what the toxicological elements of a nanoparticle are and engineer those out."

http://www.miller-mccune.com/science-environment/toxicology-of-the-tiny-7171/