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Sistema de Infotecas Centrales, Universidad Autónoma de Coahuila

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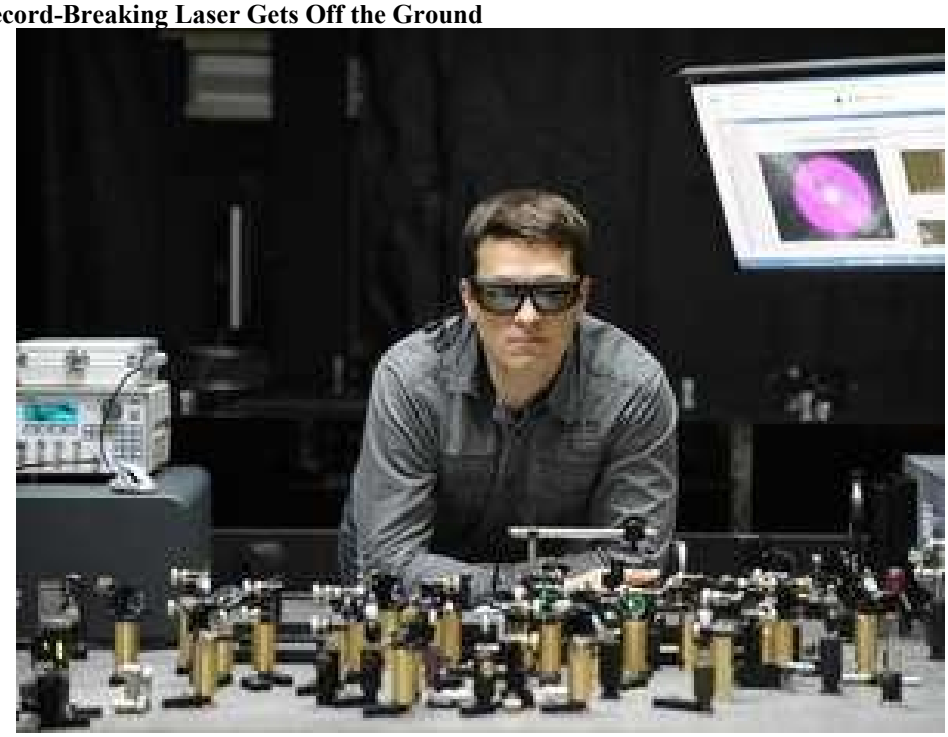
Construction of a Record-Breaking Laser Gets Off the Ground



Dr Yuriy Stepanenko from the Institute of Physical Chemistry of the PAS in Warsaw at the optical table with a laser setup. (Credit: IPC PAS, Grzegorz Krzyżewski)

ScienceDaily (Mar. 16, 2011) — In the Laser Centre of the Institute of Physical Chemistry of the Polish Academy of Sciences and the Faculty of Physics of the Warsaw University work has started on the construction of an innovative laser. The compact device will make use of a unique light amplification technology to allow single laser pulses to reach the power of tens of terawatts with world record-breaking amplification parameters.

Most lasers amplify light by making use of classical technology with titanium ions doped sapphire crystals. An external laser is used to pump energy into the crystal where a part of the energy is subsequently taken over by a laser beam being amplified. Laser crystals have, however, numerous disadvantages, e.g., they warm up strongly and distort the cross section of the laser beam. An alternative is provided by parametric amplifiers that exploit non-linear optical effects. A laser with such an amplifier is being developed in the Laser Centre at the Institute of Physical Chemistry of the Polish Academy of Sciences (IPC PAS) and the Faculty of Physics of the Warsaw University (FPWU). „Our goal is simple. We want to construct the most efficient and compact parametric amplifier in the world" -- says Dr Yuriy Stepanenko from IPC PAS.

The multi-pass optical parametric amplifier technology NOPCPA (Noncollinear Optical Parametric Chirped Pulse Amplifier) has been for several years developed in the Laser Centre in a group headed by Prof. Czesław Radzewicz (IPC PAS, FPWU). The method consists in an efficient energy transfer directly from the pumping laser beam to the beam being amplified. Combined with numerical modelling, theoretical tools developed by Polish researchers allow to optimize precisely the parameters of both beams and of the amplifier. These issues are non-trivial as field intensity distributions are inhomogeneous in time and space, and in addition the pulse being amplified has a time-dependent frequency (which the physicists call a chirp).

As no energy is being accumulated in a parametric amplifier, there are no damaging thermal effects, and the amplified pulses have excellent parameters. A NOPCPA amplifier has also compact dimensions: a length of several centimetres is enough to reach an amplification of hundreds of millions of times. Theoretical efficiency of such an amplifier is approximately 60% but it is difficult to get, and so far the best laser amplifier of this type reach below 30%. „Our minimum plan is to reach an efficiency of 40%, we will try, however, to overcome a barrier of 50%" -- says Dr Paweł Wnuk (IPC PAS).

The researchers expect to get the first 10 terawatt pulses with duration of dozen femtoseconds emitted by their laser next year. But this is only the beginning of the way. „We hope that already the present version of the parametric amplifier will allow us to generate over 100 TW pulses" -- stresses Prof. Radzewicz. The calculations indicate that 500 TW laser pulses could be used to accelerate protons to energies enabling them to be applied in medical therapies including anti-cancer treatment. The lasers with so high power can be found today only in a few research centres worldwide. „We have all the grounds to assume that our method of light amplification can in future help us to build relatively cheap lasers for proton acceleration, in addition with so compact size that they essentially would be considered portable devices" -- says Dr Stepanenko.
Under the research project being completed the new laser will be used to construct two demonstration setups. The first one, being developed in collaboration with the Military Academy of Technology (MAT) in Warsaw and the Institute of Physics of the PAS, will be used to construct x-ray sources with micrometric dimensions. Such sources are used in, e.g., x-ray microscopy, and in particular in non-destructive testing of structural materials. The second demonstrator will be a lidar for measurements of atmospheric pollution and will be developed with participation of the researchers from the Military Academy of Technology.
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The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Institute of Physical Chemistry of the Polish Academy of Sciences**, via AlphaGalileo.

http://www.sciencedaily.com/releases/2011/03/110316084915.htm

Plasticity of Plants Helps Them Adapt to Climate Change

Spring. Each plant responds in different ways to temperature changes. (Credit: Fernando Valladares)

ScienceDaily (Mar. 17, 2011) — An international study, with Spanish participation, has shown that the phenotypic plasticity of plants, which enables them to change their structure and function, helps them to adapt to environmental change. This research will make it easier to anticipate plants' response to current climate change.

The study, which has been published in *Trends in Plant Science*, provides an overview of plants' molecular and genetic mechanisms, which is important for ecologists, physiologists and molecular biologists, since it covers the prime requirements for anticipating plants' response to global change.

The results show that plants in natural and agricultural systems have "the capacity to adapt to a changing environment without requiring any evolutionary changes, which always happens over several generations," Fernando Valladares, one of the authors of the paper and a researcher at the National Museum of Natural Sciences (CSIC), said.

All plant species exhibit a greater or lesser degree of plasticity. "Various studies suggest that species from more heterogeneous and changing environments have greater degrees of plasticity. For example, plants from these environments have great root plasticity in order to be able to take better advantage of fertile and damp areas and to avoid sterile, dry ones," Valladares explains.

Plants' pigmentation, root length, leaf mass and efficiency of water use are some of the leading indicators used to study the phenotypic plasticity of plant organisms.

"The differences in plasticity and its mechanisms allow us to better understand why various plant species grow where they do. This will enable us to project their most likely ranges in climate change scenarios," the researcher says.

Less productivity, greater survival

The advantages of plants changing their structure and function in the face of environmental change "could lead to the selection -- in the case of crops -- of more plastic varieties, which may not necessarily be the most productive, nor have the most easily-predictable productivity," the scientist stresses.

According to Valladares, the next step is "to understand the mechanisms that underlie plasticity, such as epigenetics -- non-genetic factors that determine an organism's development -- and how this impacts on the biological efficacy of wild species or on the long-term yield of agricultural species."

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Plataforma SINC**, via AlphaGalileo.

Journal Reference:

1. A.B. Nicotra, O.K. Atkin, S.P. Bonser, A.M. Davidson, E.J. Finnegan, U. Mathesius, P. Poot, M.D. Purugganan, C.L. Richards, F. Valladares. **Plant phenotypic plasticity in a changing climate**. *Trends in Plant Science*, 2010; 15 (12): 684 DOI: 10.1016/j.tplants.2010.09.008

http://www.sciencedaily.com/releases/2011/03/110316084909.htm

Biodiversity Conservation: Zoos Urged to Breed Animals from Threatened Populations

Pandas in a zoo. Of around seven land vertebrate species whose survival in the wild is threatened one is also kept in captivity. (Credit: iStockphoto/Beti Gorse)

ScienceDaily (Mar. 17, 2011) — Of around seven land vertebrate species whose survival in the wild is threatened one is also kept in captivity. These and other data on the protection of species in zoos and aquaria have now been revealed by scientists at the Max Planck Institute for Demographic Research (MPIDR) in Rostock.

Writing in the journal *Science*, the team of researchers and the International Species Information System (ISIS) advocate the establishment of targeted captive breeding programmes to supplement the protection of animals in the wild. To do this, zoos should team up in networks and shelter these animals, as a form of life insurance, until they can be released back into the wild.

The researchers used data from the International Species Information System (ISIS) to calculate how many of the endangered species can already be found at zoological gardens: 20 to 25 percent of all endangered mammal species are kept at zoos. The overall figure for birds is only slightly less than that, but is much lower for avian species that are acutely at risk of extinction: only nine percent of these are found in captivity. Only three percent of endangered amphibian species are kept in captivity.

The role of zoos for species conservation must not be underestimated, Dalia Conde and Alexander Scheuerlein have stressed. "While it is true that the number of endangered species and individual animals at any one zoo is small," say the biologists, who conduct their research at the MPIDR's Laboratory of Evolutionary Biodemography, "if several institutions link up, zoological gardens will have a considerable collective potential to breed endangered animal species."

Specialist zoos for greater breeding success

The Science authors advocate the establishment of "specialist zoos" that concentrate on breeding just one or a small number of species: "Specialisation generally increases breeding success," say Conde and Scheuerlein. "The animals can be 'parked' at these zoos until they have a chance of survival in the natural environment and can then be returned to the wild." Nate Flesness, who is the scientific director of largest data holdings of zoos (ISIS), and is also co-author of the paper stressed hat it also makes a lot of sense to include animals in breeding programmes at an early stage, before their stocks in the wild decline too much. "Zoos should not be regarded as a last-resort emergency ward, because the chances of successful breeding are decreased if the last surviving, weakened individuals of a species need to be used for this purpose."

Recently, the International Union for Conservation of Nature (IUCN) has also determined how successful captive breeding is at supporting species protection: breeding at zoos has played a key role in 17 of the 68 vertebrate species whose risk status has now been downgraded by the organisation. Examples of these success stories include the Asiatic wild horse (Przewalski's horse), the black-footed ferret (a member of the mustelid family) and the Californian condor.

Breeding programmes at zoos also deliver new demographic data which are useful in species conservation: When is the onset of sexual maturity in an animal species? What is its litter or clutch size? At what intervals

does a species reproduce? "Such fundamental data on their demographic development are unknown for many species," say Dalia Conde and Alexander Scheuerlein. "However, they are urgently needed to allow us to estimate the future fate of a species and its chances of survival in the wild."

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Max-Planck-Gesellschaft**, via EurekAlert!, a service of AAAS.

Journal Reference:

1. D. A. Conde, N. Flesness, F. Colchero, O. R. Jones and A. Scheuerlein. **An Emerging Role of Zoos to Conserve Biodiversity**. *Science*, 18 March 2011: Vol. 331 no. 6023 pp. 1390-1391 DOI: 10.1126/science.1200674

http://www.sciencedaily.com/releases/2011/03/110317141416.htm

Flowering Plant Study 'Catches Evolution in the Act'

A new UF study published March 17, 2011 in Current Biology uses this hybrid species, Tragopogon miscellus, to understand evolutionary patterns of flowering plants. Sometimes referred to as "John-go-to-bed-at-noon," the flower of the plant only blooms for a few hours in the morning. (Credit: Florida Museum of Natural History photo by Jeff Gage)

ScienceDaily (Mar. 17, 2011) — A new University of Florida study shows when two flowering plants are crossed to produce a new hybrid, the new species' genes are reset, allowing for greater genetic variation. Researchers say the study, to be published March 17 in *Current Biology*, could lead to a better understanding of how to best grow more stable and higher yielding agricultural crops.

"We caught evolution in the act," said Doug Soltis, a distinguished professor in UF's biology department and study co-author. "New and diverse patterns of gene expression may allow the new species to rapidly adapt in new environments."

The study shows the new plant species had relaxed control of gene expression in its earliest generations. But today, after 80 years of evolution, control has been regained, allowing for the production of different patterns of gene expression in different plants. The new species was remade in UF greenhouses as well as studied in its natural habitat.

Researchers analyzed *Tragopogon miscellus*, a species in the daisy family that originated naturally through hybridization in the northwest U.S. about 80 years ago. The new species formed when two species introduced from Europe mated to produce a hybrid offspring. The species mated before in Europe, but the hybrids were never successful. However, in America something new happened -- the number of chromosomes in the hybrid spontaneously doubled, and at once it became larger than its parents and quickly spread.

"No one had extended this to natural populations and the rapidity at which this can occur, and that's pretty astonishing," said Jonathan Wendel, professor and chairman of the department of ecology, evolution, and organismal biology at Iowa State University. "That species is such a beautiful model for that."

Hybridization with chromosome doubling is a prominent mode of species formation and through this study scientists can better understand how different plant groups originated.

"Understanding the impacts this process has on genome structure may help understand how best to breed crops for high and stable yields," said study co-author Pat Schnable, director of the Center for Plant Genomics at Iowa State University.

Before discovering their relaxed gene expression, the team had expected the artificial hybrids to exhibit a combination of the parents' genes, said study co-author Pam Soltis, curator of molecular systematics and evolutionary genetics at the Florida Museum of Natural History on the UF campus.

"What we found was a surprise," said lead author Richard Buggs of Queen Mary University of London, who worked on the study as a postdoctoral researcher at the Florida Museum. "It's as if hybridization and chromosome doubling hit a reset button on gene expression, turning them all on -- this could allow subsequent generations to experiment by switching off different genes."

The expression of the hybrid plant's genes in all tissues at all times allowed natural selection to shape what would emerge generations later, Pam Soltis said. With this form of hybridization, there is the opportunity for

parental patterns to be equalized, as if the hybrid has a fresh chance to exhibit a wide variety of genetic expressions over time.
Its two parent species, *Tragopogon dubius* and *Tragopogon pratensis*, were introduced to the U.S. in the 1920s. The researchers started making the artificial hybrids in 2004 and the plants take about one year to grow from seed to being able to produce seeds, Pam Soltis said.
"*Tragopogon miscellus* is unique because we actually know when it originated," Pam Soltis said. "Museum collections tell us when the parent species were introduced, allowing us to infer the age of the hybrid species."
The researchers studied 144 duplicated gene pairs from the 40-generation-old *Tragopogon miscellus*, whose common name is goatsbeard. Because the flower of the plant only blooms for a few hours in the morning, it is often referred to as "John-go-to-bed-at-noon." It looks like a daisy except for being either purple or yellow in color.
"The Soltises are showing at the genetic level how this really important process of genome doubling generates new biological diversity," Wendel said. "This leads to new questions and the design of new experiments that can help us understand the ecological and evolutionary consequences of the genetic changes they're observing."
The study was funded by the National Science Foundation and co-authors include Linjing Zhang of Shanxi Normal University, formerly with UF; Jennifer Tate of Massey University, formerly with UF; Nicholas Miles and Brad Barbazuk of UF; and Lu Gao, Wu Wei and Patrick Schnable of Iowa State University.

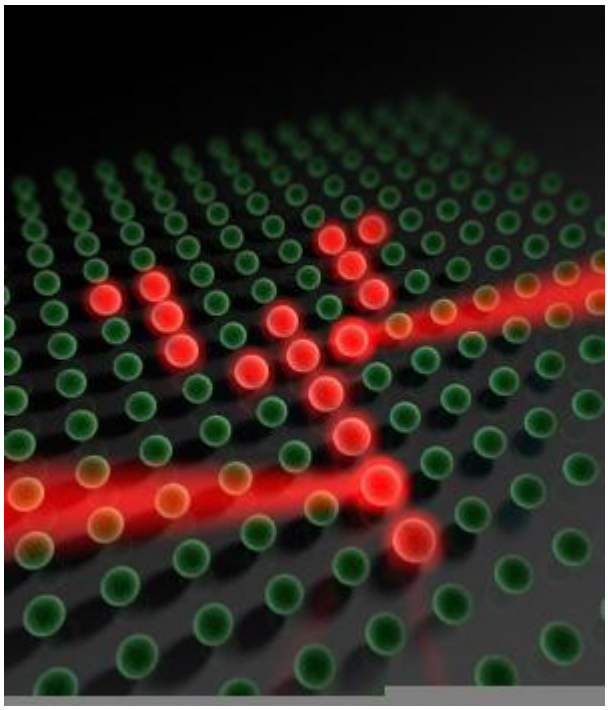
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of Florida**. The original article was written by Danielle Torrent.

Journal Reference:

1. Richard J.A. Buggs, Linjing Zhang, Nicholas Miles, Jennifer A. Tate, Lu Gao, Wu Wei, Patrick S. Schnable, W. Brad Barbazuk, Pamela S. Soltis, and Douglas E. Soltis. **Transcriptomic Shock Generates Evolutionary Novelty in a Newly Formed, Natural Allopolyploid Plant**. *Current Biology*, 2011; DOI: 10.1016/j.cub.2011.02.016

http://www.sciencedaily.com/releases/2011/03/110317131034.htm

Quantum Pen for Single Atoms Is a Big Step Toward Large Scale Quantum Computing



With the help of a laser beam, the scientists could address single atoms in the lattice of light and change their spin state. In this way they succeeded in having total control over the single atoms and in "writing" arbitrary two-dimensional patterns. (Credit: Image courtesy of Max Planck Institute of Quantum Optics)

ScienceDaily (Mar. 17, 2011) — Physicists at the Max Planck Institute of Quantum Optics succeeded in manipulating atoms individually in a lattice of light and in arranging them in arbitrary patterns. These results are an important step towards large scale quantum computing and for the simulation of condensed matter systems.

Physicists around the world are searching for the best way to realize a quantum computer. Now scientists of the team around Stefan Kuhr and Immanuel Bloch at the Max Planck Institute of Quantum Optics (Garching/Munich) took a decisive step in this direction. They can now address and change the spin of single atoms with laser light and arrange them in arbitrary patterns. In this way, the physicists strung the atoms along a line and could directly observe their tunneling dynamics in a “racing duel” of the atoms. A register of hundreds of addressable quantum particles could serve for storing and processing of quantum information in a quantum computer.

In the present experiment, the scientists loaded laser-cooled rubidium atoms into an artificial crystal of light. These so-called optical lattices are generated by superimposing several laser beams. The atoms are kept in the lattice of light in a way similar to marbles being contained in the hollows of an egg carton.

A few months ago, the team of Stefan Kuhr and Immanuel Bloch showed that each site of the optical lattice can be filled with exactly one atom. With the help of a microscope, the scientists visualized the array atom by atom and thereby verified the shell-like structure of this “Mott insulator.” Now the scientists succeeded in individually addressing the atoms in the lattice and in changing their respective energy state. Using the microscope, they focused a laser beam down to a diameter of about 600 nanometers, which is just above the lattice spacing, and directed it at individual atoms with high precision.

The laser beam slightly deforms the electron shell of the addressed (targeted) atom and thereby changes the energy difference between its two spin states. Atoms with a spin – i.e. an intrinsic angular momentum –

behave like little magnetic needles that can align in two opposite directions. If the atoms are irradiated with microwaves that are in resonance with the modified spin transition, only the addressed atoms absorb a microwave photon, which causes their spin to flip. All other atoms in the lattice remain unaffected by the microwave field.

The scientists demonstrated the high fidelity of this addressing scheme in a series of experiments. For this purpose, the spins of all atoms along a line were flipped one after the other, by moving the addressing laser from lattice site to lattice site. After removing all atoms with a flipped spin from the trap, the addressed atoms are visible as holes, which can easily be counted. In this way, the physicists deduced that the addressing worked in 95% of the cases. Atoms at the neighboring sites are not influenced by the addressing laser. The method provides the possibility to generate arbitrary distributions of atoms in the lattice.

Starting from an arrangement of 16 atoms that were strung together on neighboring lattice sites like a necklace of beads, the scientists studied what happens when the height of the lattice is ramped down so far that the particles are allowed to "tunnel" according to the rules of quantum mechanics. They move from one lattice site to the other, even if their energy is not sufficient to cross the barrier between the lattice wells. "As soon as the height of the lattice has reached the point where tunneling is possible, the particles start running as if they took part in a horse-race", doctoral candidate Christof Weitenberg describes. "By taking snapshots of the atoms in the lattice at different times after the "starting signal", we could directly observe the quantum mechanical tunneling-effect of single massive particles in an optical lattice for the first time."

The new addressing technique allows many interesting studies of the dynamics of collective quantum states, as they appear in solid state systems. It also opens new perspectives in quantum information processing. "A Mott isolator with exactly one atom per lattice site acts as a natural quantum register with a few hundred quantum bits, the ideal starting point for scalable quantum information processing," as Stefan Kuhr explains. "We have shown that we can individually address single atoms. In order for the atom to suit as a quantum bit, we need to generate coherent superpositions of its two spin states. A further step is to realize elementary logical operations between two selected atoms in the lattice, so-called quantum gates."

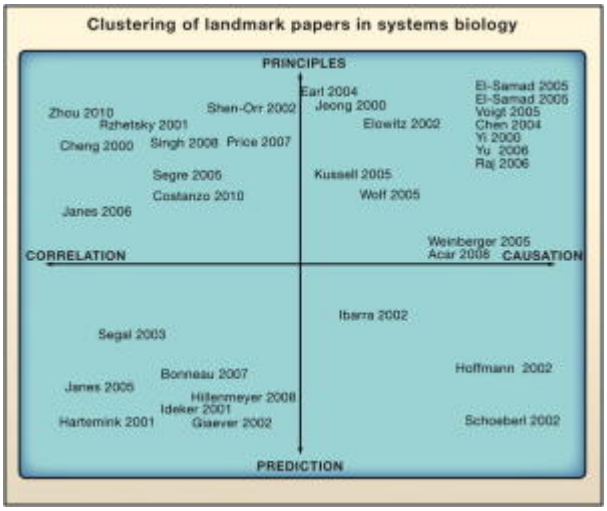
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Max Planck Institute of Quantum Optics**.

Journal Reference:

1. Christof Weitenberg, Manuel Endres, Jacob F. Sherson, Marc Cheneau, Peter Schauß, Takeshi Fukuhara, Immanuel Bloch, Stefan Kuhr. **Single-spin addressing in an atomic Mott insulator**. *Nature*, 2011; 471 (7338): 319 DOI: 10.1038/nature09827

http://www.sciencedaily.com/releases/2011/03/110317093347.htm

Scientists Take a Look at Systems Biology and Cellular Networking



This scheme for organizing systems biology research results is based on whether a study focused more on mechanistic insight or on large-scale correlation analysis (x axis) and whether the results were primarily about cellular networks or behavior predictions (y axis). (Credit: Image courtesy of Cell)

ScienceDaily (Mar. 17, 2011) — Systems biology is a holistic approach to the study of how a living organism emerges from the interactions of the individual elements that make up its constituent cells. Embracing a broad range of disciplines, this field of science that is just beginning to come into public prominence holds promise for advances in a number of important areas, including safer, more effective pharmaceuticals, improved environmental remediation, and clean, green, sustainable energy. However, the most profound impact of systems biology, according to one of its foremost practitioners, is that it might one day provide an answer to the central question: What is life?

Adam Arkin, director of the Physical Biosciences Division of the U.S. Department of Energy (DOE)'s Lawrence Berkeley National Laboratory and a leading computational biologist, is the corresponding author of an essay in the journal *Cell* which describes in detail key technologies and insights that are advancing systems biology research. The paper is titled "Network News:Innovations in 21st Century Systems Biology." Co-authoring the article is David Schaffer, a chemical engineer with Berkeley Lab's Physical Biosciences Division. Both Arkin and Schaffer also hold appointments with the University of California (UC) Berkeley.

"System biology aims to understand how individual elements of the cell generate behaviors that allow survival in changeable environments, and collective cellular organization into structured communities," Arkin says. "Ultimately, these cellular networks assemble into larger population networks to form large-scale ecologies and thinking machines, such as humans."

In their essay, Arkin and Schaffer argue that the ideas behind systems biology originated more than a century ago and that the field should be viewed as "a mature synthesis of thought about the implications of biological structure and its dynamic organization." Research into the evolution, architecture, and function of cells and cellular networks in combination with ever expanding computational power has led to predictive genome-scale regulatory and metabolic models of organisms. Today systems biology is ready to "bridge the gap between correlative analysis and mechanistic insights" that can transform biology from a descriptive science to an engineering science.

Discoveries in systems biology, the authors say, can generally be divided between those that relied on a "mechanistic approach to causal relationships," and those that relied on "large-scale correlation analysis." The results of these discoveries can also be categorized according to whether they primarily pertained to the principles behind cellular network organization, or to predictions about the behavior of these networks.

"As systems biology matures, the number of studies linking correlation with causation and principles with prediction will continue to grow," Schaffer says. "Advances in measurement technologies that enable large-scale experiments across an array of parameters and conditions will increasingly meld these correlative and

causal approaches, including correlative analyses leading to mechanistic hypothesis testing, as well as causal models empowered with sufficient data to make predictions."
As the complete genomes of more organisms are sequenced, and measurement and genetic manipulation technologies are improved, scientists will be able to compare systems across a broader expanse of phylogenetic trees. This, Arkin and Schaffer say, will enhance our understanding of mechanistic features that are necessary for function and evolution.
"The increasing integration of experimental and computational technologies will thus corroborate, deepen, and diversify the theories that the earliest systems biologists used logic to infer," Arkin says. "This will thereby inch us ever closer to answering the What is Life question."
The systems biology research cited in this essay by Arkin and Schaffer was supported by DOE's Office of Science (Biological and Environmental Research), and by the National Institutes of Health.

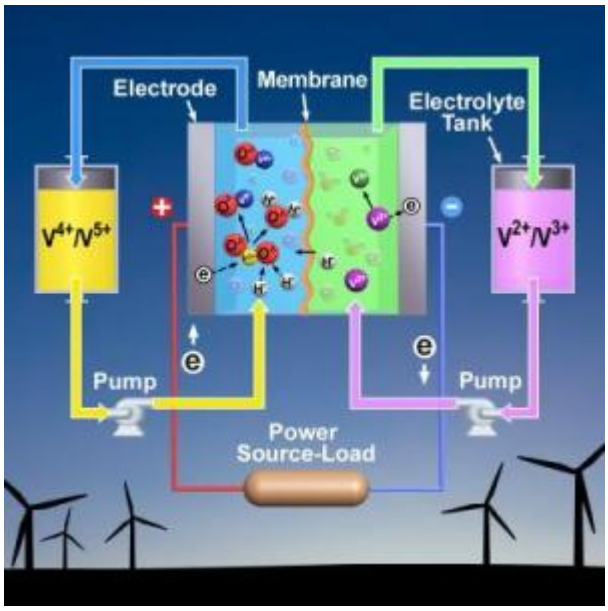
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **DOE/Lawrence Berkeley National Laboratory**.

Journal Reference:

1. Adam P. Arkin and David V. Schaffer. **Network News: Innovations in 21st Century Systems Biology**. *Cell*, Volume 144, Issue 6, 844-849, 18 March 2011 DOI: 10.1016/j.cell.2011.03.008

http://www.sciencedaily.com/releases/2011/03/110317141436.htm

Electric Grid Reliability: Increasing Energy Storage in Vanadium Redox Batteries by 70 Percent



This artist's rendering of an upgraded vanadium redox battery shows how using both hydrochloric and sulfuric acids in the electrolyte significantly improves the battery's performance and could also improve the electric grid's reliability and help connect more wind turbines and solar panels to the grid. (Credit: Pacific Northwest National Laboratory)

ScienceDaily (Mar. 17, 2011) — Though considered a promising large-scale energy storage device, the vanadium redox battery's use has been limited by its inability to work well in a wide range of temperatures and its high cost. But new research indicates that modifying the battery's electrolyte solution significantly improves its performance. So much so that the upgraded battery could improve the electric grid's reliability and help connect more wind turbines and solar panels to the grid.

In a paper published by the journal *Advanced Energy Materials,* researchers at the Department of Energy's Pacific Northwest National Laboratory found that adding hydrochloric acid to the sulfuric acid typically used in vanadium batteries increased the batteries' energy storage capacity by 70 percent and expanded the temperature range in which they operate.

"Our small adjustments greatly improve the vanadium redox battery," said lead author and PNNL chemist Liyu Li. "And with just a little more work, the battery could potentially increase the use of wind, solar and other renewable power sources across the electric grid."

Unlike traditional power, which is generated in a reliable, consistent stream of electricity by controlling how much coal is burned or water is sent through dam turbines, renewable power production depends on uncontrollable natural phenomena such as sunshine and wind. Storing electricity can help smooth out the intermittency of renewable power while also improving the reliability of the electric grid that transmits it. Vanadium batteries can hold on to renewable power until people turn on their lights and run their dishwashers. Other benefits of vanadium batteries include high efficiency and the ability to quickly generate power when it's needed as well as sit idle for long periods of time without losing storage capacity.

A vanadium battery is a type of flow battery, meaning it generates power by pumping liquid from external tanks to the battery's central stack, or a chamber where the liquids are mixed. The tanks contain electrolytes, which are liquids that conduct electricity. One tank has the positively-charged vanadium ion V5+ floating in its electrolyte. And the other tank holds an electrolyte full of a different vanadium ion, V2+. When energy is needed, pumps move the ion-saturated electrolyte from both tanks into the stack, where a chemical reaction causes the ions to change their charge, creating electricity.

To charge the battery, electricity is sent to the vanadium battery's stack. This causes another reaction that restores the original charge of vanadium ions. The electrical energy is converted into chemical energy stored

in the vanadium ions. The electrolytes with their respective ions are pumped back into to their tanks, where they wait until electricity is needed and the cycle is started again.
A battery's capacity to generate electricity is limited by how many ions it can pack into the electrolyte. Vanadium batteries traditionally use pure sulfuric acid for their electrolyte. But sulfuric acid can only absorb so many vanadium ions.
Another drawback is that sulfuric acid-based vanadium batteries only work between about 50 and 104 degrees Fahrenheit (10 to 40 Celsius). Below that temperature range, the ion-infused sulfuric acid crystallizes. The larger concern, however, is the battery overheating, which causes an unwanted solid to form and renders the battery useless. To regulate the temperature, air conditioners or circulating cooling water are used, which causes up to 20 percent energy loss and significantly increasing the battery's operating cost, the researchers noted.
Wanting to improve the battery's performance, Li and his colleagues began searching for a new electrolyte. They tried a pure hydrochloric acid electrolyte, but found it caused one of the vanadium ions to form an unwanted solid. Next, they experimented with various mixtures of both hydrochloric and sulfuric acids. PNNL scientists found the ideal balance when they mixed 6 parts hydrochloric acid with 2.5 parts sulfuric acid. They verified the electrolyte and ion molecules present in the solution with a nuclear magnetic resonance instrument and the Chinook supercomputer at EMSL, DOE's Environmental Molecular Sciences Laboratory at PNNL.
Tests showed that the new electrolyte mixture could hold 70 percent more vanadium ions, making the battery's electricity capacity 70 percent higher. The discovery means that smaller tanks can be used to generate the same amount of power as larger tanks filled with the old electrolyte.
And the new mixture allowed the battery to work in both warmer and colder temperatures, between 23 and 122 degrees Fahrenheit (-5 to 50 Celsius), greatly reducing the need for costly cooling systems. At room temperature, a battery with the new electrolyte mixture maintained an 87 percent energy efficiency rate for 20 days, which is about the same efficiency of the old solution.
The results are promising, but more research is needed, the authors noted. The battery's stack and overall physical structure could be improved to increase power generation and decrease cost.
"Vanadium redox batteries have been around for more than 20 years, but their use has been limited by a relatively narrow temperature range," Li said. "Something as simple as adjusting the batteries' electrolyte means they can be used in more places without having to divert power output to regulate heat."
This research was supported by DOE's Office of Electricity Delivery and Energy Reliability and internal PNNL funding.

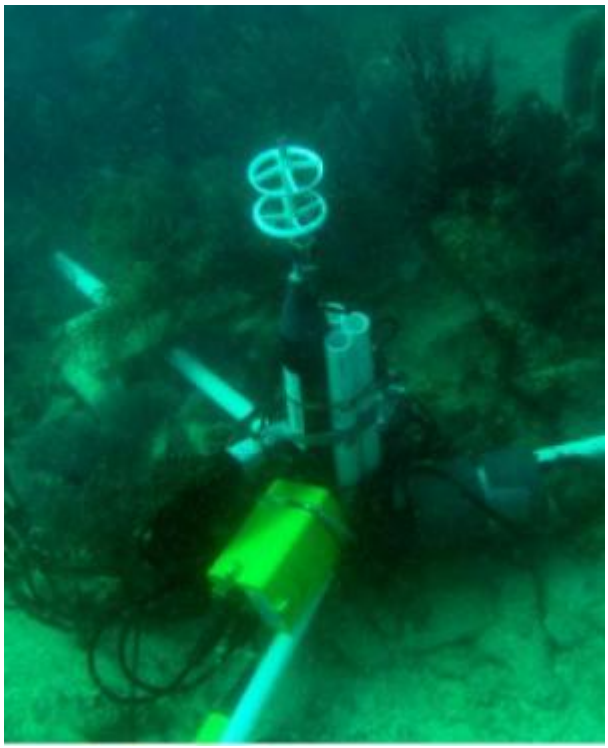
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **DOE/Pacific Northwest National Laboratory**.

Journal Reference:

1. Liyu Li, Soowhan Kim, Wei Wang, M. Vijayakumar, Zimin Nie, Baowei Chen, Jianlu Zhang, Guanguang Xia, Jianzhi Hu, Gordon Graff, Jun Liu, Zhenguo Yang. **A Stable Vanadium Redox-Flow Battery with High Energy Density for Large-Scale Energy Storage**. *Advanced Energy Materials*, 2011; DOI: 10.1002/aenm.201100008

http://www.sciencedaily.com/releases/2011/03/110317141418.htm

New Tool to Monitor Coral Reef 'Vital Signs'



A team of scientists from the University of Miami, University of Puerto Rico, WHOI, Doherty Earth Observatory and the USGS developed and tested a new methods to monitor biological productivity at Cayo Enrique Reef in Puerto Rico. The invention measures dissolved oxygen production and consumption rates, allowing scientists to monitor the balance between the production of new organic matter by corals and algae, and the consumption of that organic matter by the reef's heterotrophs, which are essential to assessing the health of coral reef ecosystems. (Credit: C. Langdon)

ScienceDaily (Mar. 17, 2011) — University of Miami (UM) Rosenstiel School of Marine & Atmospheric Science scientist Chris Langdon and colleagues developed a new tool to monitor coral reef vital signs. By accurately measuring their biological pulse, scientists can better assess how climate change and other ecological threats impact coral reef health worldwide.

During a March 2009 experiment at Cayo Enrique Reef in Puerto Rico, the team tested two new methods to monitor biological productivity. They compared a technique that measures changes in dissolved oxygen within a chamber that encloses an area of water above the reef with one that measures the flux of dissolved oxygen across the turbulent boundary layer above an unconfined portion of the seafloor.

By measuring dissolved oxygen production and consumption rates, scientists were able to monitor the balance between the production of new organic matter by the corals and algae and the consumption of that organic matter by the reef's heterotrophs, which are essential to assessing the health of coral reef ecosystems.

A combination of these methods is a valuable tool for assessing and studying the effects of climate change on coral reef health, according to the authors.

According to a recent analysis by the World Resources Institute, nearly 75 percent of the world's coral reefs are currently threatened by human activities and ecological disturbances, such as rising ocean temperatures, increased pollution, overfishing and ocean acidification.

Measurements of biological productivity have typically been made by tracing changes in dissolved oxygen in seawater as it passes over a reef. However, this is a labor intensive and difficult method, requiring repeated measurements. The new method opens up the possibility of making long-term, unattended, high-temporal resolution measurements of photosynthesis and respiration of coral reefs and any other benthic ecosystems.

The study was published in the March issue of the journal *Geophysical Research Letters*. The paper's co-authors are Langdon, Wade R. McGillis of Lamont Doherty Earth Observatory, Brice Loose of Woods Hole Oceanographic Institution, Kim K. Yates of the U.S. Geological Survey, and Jorge Corredor of the University of Puerto Rico.

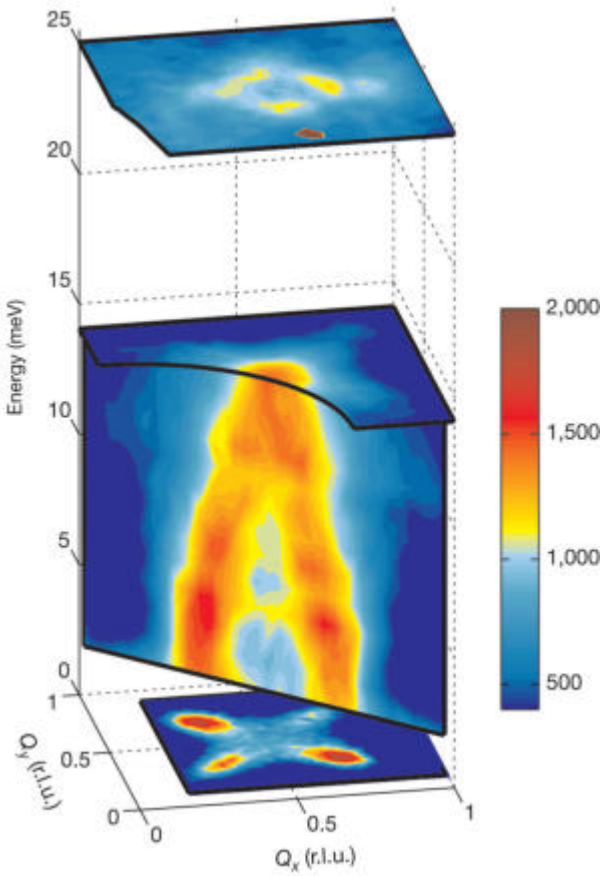
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of Miami Rosenstiel School of Marine & Atmospheric Science**, via EurekAlert!, a service of AAAS.

Journal Reference:

1. W. R. McGillis, C. Langdon, B. Loose, K. K. Yates, Jorge Corredor. **Productivity of a coral reef using boundary layer and enclosure methods**. *Geophysical Research Letters*, 2011; 38 (3) DOI: 10.1029/2010GL046179

http://www.sciencedaily.com/releases/2011/03/110317102559.htm

Understanding the Magnetic Glue Superconductivity



Neutron scattering intensity maps of the magnetic excitation spectrum of La5/3Sr1/3CoO4. (Credit: Image courtesy of Institut Laue-Langevin (ILL))

ScienceDaily (Mar. 17, 2011) — New evidence suggests fluctuating magnetic stripes are the cause of mysterious hourglass magnetic spectrum of high temperature superconductors.

Scientists at Oxford University and the Institut Laue-Langevin have used neutrons to probe the magnetic glue thought to produce high temperature superconductivity and have identified stripes of magnetic moments and charge as the cause of a strange hourglass-shaped magnetic spectrum. Their findings, reported in *Nature*, will aid the search for a model of high temperature superconductivity.

Current research into the origins of high temperature superconductivity found in a large class of copper oxide compounds centres on the motion of atomic magnetic moments. Fluctuations of these moments are believed to create an attractive force which binds electrons in pairs and allows them to move around unimpeded giving rise to superconductivity.

Recent debate has focused on the cause of an unusual hourglass shape found in the spectrum of these magnetic fluctuations. The origin of this pattern, which is found in many if not all high temperature superconductors, is thought to relate to an alternating pattern of spin and charge stripes found within the atomic layers. However, efforts to prove this link have been hampered by the weakness of the magnetic signal from the superconductors and by changes in the spectrum caused by superconductivity.

The team instead turned their attention to an insulating cobalt oxide with a similar magnetic stripe pattern. Using neutron scattering at the ILL, the flagship centre for neutron science, the scientists measured the atomic-scale fluctuations in its magnetism and uncovered the same hourglass pattern in the data. Their results provide strong evidence that magnetic stripes are the cause of the hourglass spectrum and play an important role in high temperature superconductivity.

"Our cobalt oxide compound is a magnetic look-alike for the high temperature superconductors," says Professor Boothroyd (Oxford University). "Its lack of mobile electrons prevents it from becoming superconductive, allowing us to use neutron scattering to look in detail at nano-scale fluctuations in the magnetic motion without the complicating effects of superconductivity. The experiment allows us to isolate the source of the much-debated hour-glass spectrum."
This represents an important discovery for those aiming to model the origins of superconductivity.
"Future models must now incorporate these magnetic stripes, says Dr Paul Freeman, formerly from the ILL, now at the Helmholtz Zentrum Berlin. "And with these simple cobalt oxide compounds, we have an ideal candidate for further research into understanding the links between magnetism and high temperature superconductivity."

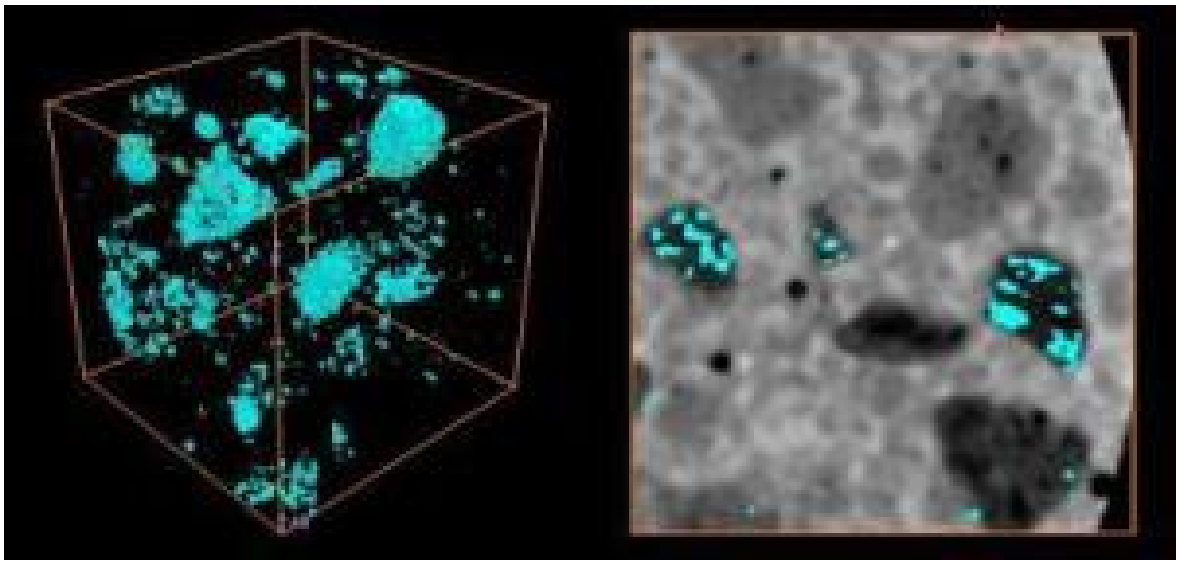
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Institut Laue-Langevin (ILL)**.

Journal Reference:

1. A. T. Boothroyd, P. Babkevich, D. Prabhakaran, P. G. Freeman. **An hour-glass magnetic spectrum in an insulating, hole-doped antiferromagnet**. *Nature*, 2011; 471 (7338): 341 DOI: 10.1038/nature09902

http://www.sciencedaily.com/releases/2011/03/110317093440.htm

High-Tech Concrete Technology Has a Famous Past



X-ray microtomograph (left) shows pores (blue) that remain within lightweight aggregates (LWAs) after water has migrated from the pre-wetted materials during the first day of hydration. In the two-dimensional image (right), the emptied pores are superimposed over the original microstructure (hydrating cement paste is white, sand is light grey, and LWA is dark grey), illustrating the detailed pore structure of LWA particles. (Credit: NIST)

ScienceDaily (Mar. 16, 2011) — In the business of concrete making, what's old -- even ancient -- is new again.

Almost 1,900 years ago, the Romans built what continues to be the world's largest unreinforced solid concrete dome in the world -- the Pantheon. The secret, probably unknown to the Emperor Hadrian's engineers at the time, was that the lightweight concrete used to build the dome had set and hardened from the inside out. This internal curing process enhanced the material's strength, durability, resistance to cracking, and other properties so that the Pantheon continues to be used for special events to this day.

But it is only within the last decade or so that internally cured concrete has begun to have an impact on modern world infrastructure. Increasingly, internally cured concrete is being used in the construction of bridge decks, pavements, parking structures, water tanks, and railway yards, according to a review of the current status of the new (or old) concrete technology just published by the National Institute of Standards and Technology (NIST).

The virtues of internally cured concrete stem from substituting light-weight, pre-wetted absorbent materials for some of the sand and/or coarse aggregates (stones) that are mixed with cement to make conventional concrete. Dispersed throughout the mixture, the water-filled lightweight aggregates serve as reservoirs that release water on an as-needed basis to nearby hydrating cement particles.

According to one study cited in the review, bridge decks made with internally cured, high-performance concrete were estimated to have a service life of 63 years, as compared with 22 years for conventional concrete and 40 years for high-performance concrete without internal curing.

"As with many new technologies, the path from research to practice has been a slow one, but as of 2010, hundreds of thousands of cubic meters" of the lighter and more durable material have been successfully used in U.S. construction, write the report's co-authors, NIST chemical engineer Dale Bentz and Jason Weiss, Purdue University civil engineering professor.

Compared with conventional varieties, internally cured concrete increases the cost of a project by 10 to 12 percent, Bentz and Weiss estimate on the basis of bridge-building projects in New York and Indiana. The increased front-end cost, they write, must be evaluated against the reduced risk of cracking, better protection against salt damage, and other improved properties that "should contribute to a more durable structure that has

a longer life and lower life-cycle costs," they write. "Further, this could have substantial benefits in a reduced disruption to the traveling public, generally producing a more sustainable solution."
The 82-page report summarizes the current practice and theory of internal curing, reviews project experiences and material performance in the field, and describes opportunities for research that could lead to enhancements in the material.

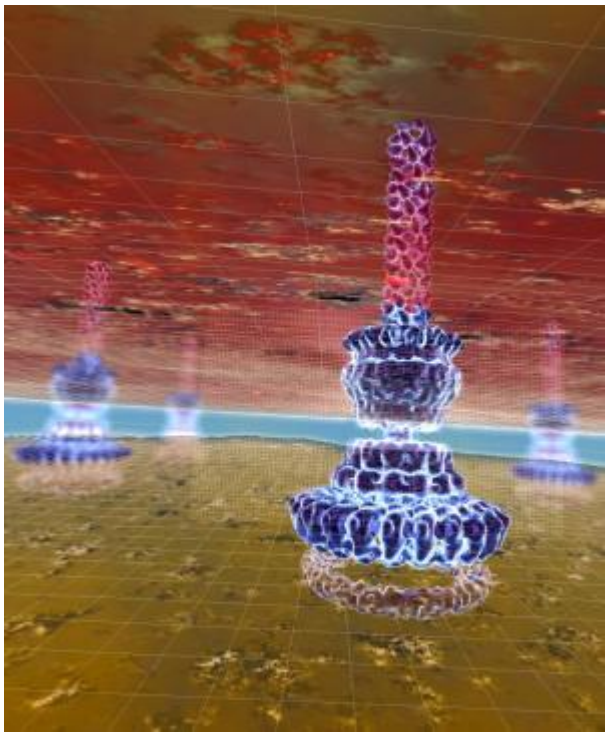
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **National Institute of Standards and Technology (NIST)**.

Journal Reference:

1. D. P. Bentz, W. J. Weiss. **Internal Curing: A 2010 State-of-the-Art Review**. *NIST Interagency/Internal Report*, 2011; 7765 [link]

http://www.sciencedaily.com/releases/2011/03/110316152951.htm

Zooming in on the Weapons of Salmonella



Structure of the needle-complex of Salmonella, embedded in a cellular context (artist's interpretation based on original data). (Credit: Copyright: IMP-IMBA)

ScienceDaily (Mar. 16, 2011) — Some of the most dreaded diseases in the world such as plague, typhoid and cholera are caused by bacteria that have one thing in common: they possess an infection apparatus which is a nearly unbeatable weapon. When attacking a cell of the body, they develop numerous hollow-needle-shaped structures that project from the bacterial surface. Through these needles, the bacteria inject signal substances into the host cells, which re-program the latter and thereby overcome their defense. From this time on it's easy game for the pathogens; they can invade the cells unimpeded and in large numbers.

The biochemist and biophysicist Thomas Marlovits, a group leader at the Vienna Institutes IMP (Research Institute of Molecular Pathology) and IMBA (Institute of Molecular Biotechnology) has been occupied for several years with the infection complex of salmonellae. As early as in 2006 Thomas Marlovits showed how the needle complex of *Salmonella* typhimurium develops (*Nature* 441, 637-640). Together with his doctoral student Oliver Schraidt he has now been able to demonstrate the three-dimensional structure of this complex in extremely high resolution. The team was able to show details with dimensions of just 5 to 6 angstroems, which are nearly atomic orders of magnitude.

Their work will be presented in the forthcoming issue of the journal *Science*.

Looks do kill!

Never before has the infection tool of salmonellae been presented in such precision. This was achieved by the combined use of high-resolution cryo-electron microscopy and specially developed imaging software. "Austria's coolest microscope" makes it possible to shock-freeze biological samples at minus 196 degrees centigrade and view them in almost unchanged condition. However, when "zooming in" on their object, scientists are confronted with a treacherous problem: the high-energy electron beam falls at such high concentrations on the sample that the latter is destroyed after the very first image.

The Viennese scientists have resolved the problem by developing new image-processing algorithms and with sheer numbers of images. They analyzed about 37,000 images of isolated needle complexes. Similar images were grouped and computed jointly. By doing so they were able to generate a single sharp image from

numerous blurred ones. This enormous computing power was created by a cluster of about 500 interconnected computers.

Microscopy without the human interference factor

The microscope works in semi-automated fashion at night to obtain the large number of images. This is very advantageous because human beings merely interfere with the job. They breathe, speak, move, and thus unsettle the sensitive microscope. Even a moving elevator may irritate the electron beam.
The cryo-electron microscope at IMP-IMBA is the only one of its kind in Austria. The immense technical effort associated with its operation pays off, as far as the scientists are concerned. Advancing into the subnanometer range created a further means of expanding their knowledge. They were able to "adjust" existing data (obtained from crystallography) to the needle structure and thus complement the three-dimensional image in a perfect manner. The use of this hybrid method enabled the scientists to elucidate the complete construction plan of the infection apparatus.
Thomas Marlovits regards this technology as an innovation boost: "Using the methods we developed for our work, we were able to establish "imaging" standards at a very high level. We can explore its absolute limits with the aid of the fantastic infrastructure we have here at Campus Vienna Biocenter."
This knowledge not only advances basic research. "Using our data, we may well be able to find a compound that interferes with the needle complex and disturb its function," says Marlovits. "We would then have a very effective medication -- one that combats not only salmonellae but also other pathogens that employ this system, such as pathogens that cause cholera, plague or typhoid."
The biochemist Thomas Marlovits was born in Rechnitz, Austria. He is a joint group leader of the two institutes IMP and IMBA since 2005. Previously, he spent five years as a post-doctoral student at the University of Yale. Thomas Marlovits has been occupied with the structure and function of molecular machines. He started to investigate the infection apparatus of salmonellae at Yale and continued this work at IMP-IMBA.
Thomas Marlovits' research work is supported within the scope of "Vienna Spots of Excellence" as part of the "Center of Molecular and Cellular Nanostructure Vienna (CMCN)," headed by Thomas Marlovits. This initiative of the City of Vienna supports research projects which involve both enterprises and scientific partners.

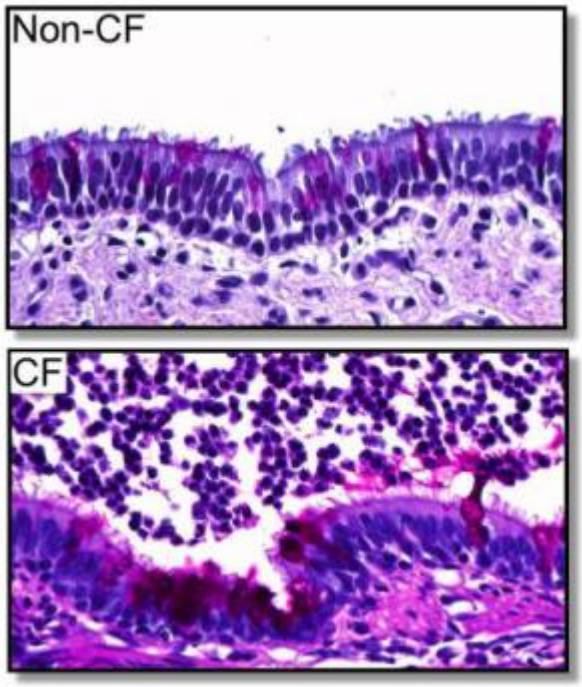
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Research Institute of Molecular Pathology**, via EurekAlert!, a service of AAAS.

Journal Reference:

1. Oliver Schraidt and Thomas C. Marlovits. **Three-Dimensional Model of Salmonella's Needle Complex at Subnanometer Resolution**. *Science*, 4 March 2011: Vol. 331 no. 6021 pp. 1192-1195 DOI: 10.1126/science.1199358

http://www.sciencedaily.com/releases/2011/03/110304115001.htm

Pig Model of Cystic Fibrosis Improves Understanding of Disease



University of Iowa researchers have created a pig model that genetically replicates the most common form of cystic fibrosis. The pigs develop disease symptoms, including gastrointestinal abnormalities and lung disease, which mimic CF in humans. The image shows cells that line the bronchial airways of non-CF (top) and CF (bottom) pigs. Hair-like cilia protrude from the tops of cells. In non-CF, air fills the airway lumen above the cells. In CF, inflammatory cells, mucus and bacteria sit in the airway lumen. In CF, more of the airway cells have a reddish-purple color indicating increased mucus production. (Credit: Lynda Ostedgaard, University of Iowa)

ScienceDaily (Mar. 16, 2011) — It's been more than 20 years since scientists first discovered the gene that causes cystic fibrosis (CF), yet questions about how the mutated gene causes disease remain unanswered. Using a newly created pig model that genetically replicates the most common form of cystic fibrosis, University of Iowa researchers have now shown that the CF protein is "misprocessed" in the pigs and does not end up in the correct cellular location. This glitch leads to disease symptoms, including gastrointestinal abnormalities and lung disease in the pigs, which mimic CF in humans. The findings are published in the March 16 issue of the journal *Science Translational Medicine*.

The findings match earlier laboratory experiments that suggested the gene mutation disrupts the process whereby the CF protein is folded into its correct shape and shipped to the membranes of cells that line the airways and other organs.

When it is correctly located at the cell membrane, this protein -- called cystic fibrosis transmembrane conductance regulator (CFTR) -- forms a channel to allow chloride ions to move in and out of cells. This ion movement is a critical component of the system that maintains salt and water balance across cell membranes in the lung as well as other organs and supports normal membrane function including eradicating bacteria from cell surfaces.

The new study shows that in pigs, the CFTR protein behaves the same way in a living animal as it does in experimental cell systems, suggesting that these experimental systems are useful for learning about the CFTR protein's properties. The cell systems and the new pig model may also be helpful in testing therapies designed to increase the amount of protein that gets to the cell membrane, or boost the activity of the protein that is located at the membrane.

"Instead of just trying to treat the symptoms of CF, current research is moving toward therapies that target mutations in the CFTR gene," said David Stoltz, M.D., Ph.D., UI assistant professor of internal medicine and

senior study author. "For example, there already are drugs known as "correctors" being tested. These drugs help CFTR move from inside the cell to its correct location on the cell surface.
"The pig model could help us develop and test more corrector drugs, and it will also help us better understand why the protein is misprocessed in the first place," Stoltz added. "If we understand what is going wrong, we may be able to develop new therapies that can target the problem and allow more of the CFTR to make it to the cell surface, which may alleviate the disease symptoms."
In 2008, the UI team and colleagues at University of Missouri created pigs that were missing the CFTR protein. These animals developed CF disease symptoms that closely mimicked the human disease. In the new pig model, the animals have two copies of the CFTR gene containing the most common CF-causing mutation, which is known as the delta F508 mutation. These pigs also develop CF symptoms similar to the human disease. In particular, the CF pigs are born with gastrointestinal disease and develop lung disease over time. By studying the protein in the pigs, the researchers were able to show that most of the CFTR protein is misprocessed and gets degraded, but a small amount of the protein does get to the cell membrane where it is able to form active chloride channels. However, the level of activity is only about 6 percent of the activity found in normal pigs with fully functional CFTR channels. The study shows that this small amount of CFTR activity is not sufficient to prevent CF disease in the pigs.
CF is a recessive disease, meaning a person with one mutated copy and one good copy of the CFTR gene is a "carrier" but does not have CF. This suggests that 50 percent of normal CFTR activity is sufficient for health. The question has always been, 'Is there a minimal amount of active CFTR that would be enough to protect people from the disease symptoms?'
"We know that people with 50 percent CFTR function have no disease, and now we know that 6 percent of full activity is not enough to prevent disease in the pigs," Stoltz said. "We still don't know how much CFTR is enough to prevent the disease, but this model animal could give us a way to investigate."
In addition to Stoltz, the UI research team included senior author Michael Welsh, M.D., UI professor of internal medicine and molecular physiology and biophysics and a Howard Hughes Medical Institute investigator, and co-first authors, Lynda Ostedgaard, Ph.D.; David Meyerholz, D.V.M., Ph.D.; and Jeng-Haur Chen, Ph.D.
This work was a collaboration between UI scientists and scientists at the University of Missouri including Dr. Randall Prather and members of his research team.
Researchers from the UI Departments of Internal Medicine, Pathology, Surgery and Pediatrics were also part of the team.
The study was funded in part by grants from the National Institutes of Health and the Cystic Fibrosis Foundation.

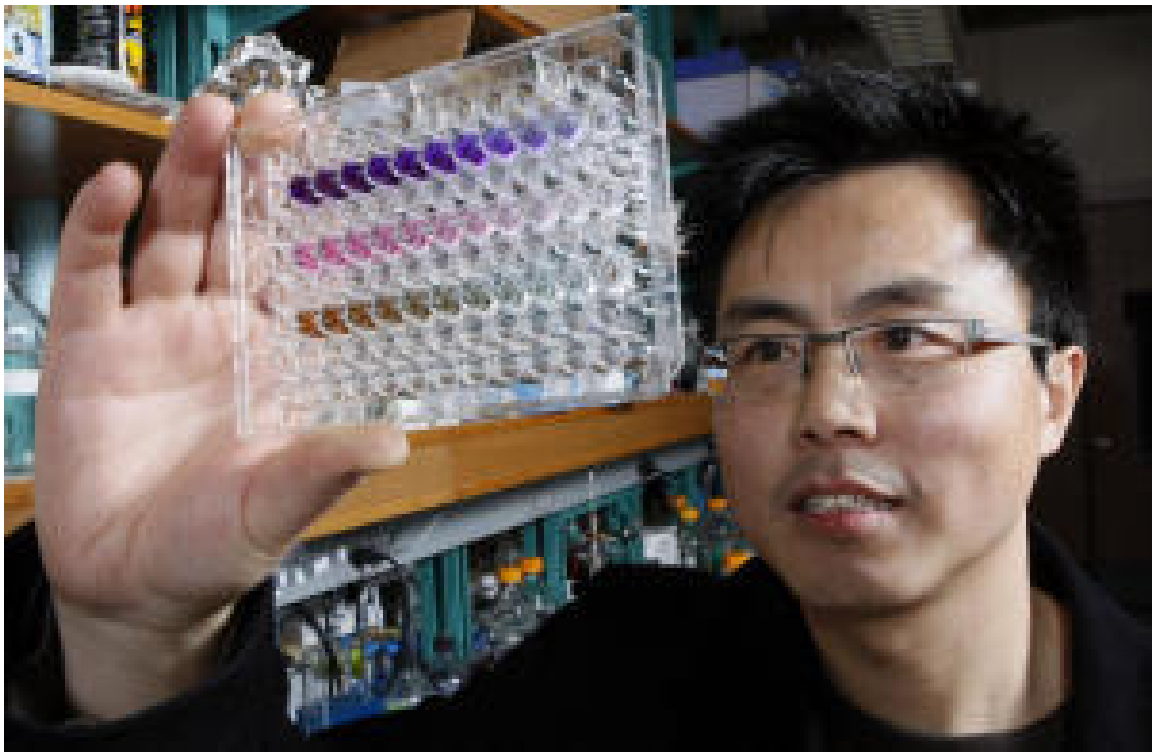
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of Iowa Health Care**, via EurekAlert!, a service of AAAS.

Journal Reference:

1. Lynda S. Ostedgaard et al. **The ΔF508 Mutation Causes CFTR Misprocessing and Cystic Fibrosis–Like Disease in Pigs**. *Science Translational Medicine*, 16 March 2011: Vol. 3, Issue 74, p. 74ra24 DOI: 10.1126/scitranslmed.3001868

http://www.sciencedaily.com/releases/2011/03/110316152947.htm

New Way to Test Cancer Drugs



W. Andy Tao uses nanopolymers and chemical reactions that cause color changes in a solution to detect activity related to cancer cell formation. (Credit: Purdue Agricultural Communication photo/Tom Campbell)

ScienceDaily (Mar. 16, 2011) — A Purdue University scientist's nanopolymer would make it easier and cheaper for drug developers to test the effectiveness of a widely used class of cancer inhibitors.

W. Andy Tao, an associate professor of biochemistry analytical chemistry and a member of the Purdue Center for Cancer Research team, created the Purdue-patented pIMAGO nanopolymer that can be used to determine whether cancer drugs have been effective against biochemical processes that can lead to cancer cell formation. The nanopolymers would attach themselves to target proteins that would later be detected by a relatively simple laboratory procedure called chemiluminescence.

Tymora Analytical, a company Tao started in the Purdue Research Park, will manufacture the pIMAGO nanopolymers. The 'p' stands for phosphor, and the IMAGO comes from the Greek word for image.

Tao's pIMAGO nanopolymers are coated in titanium ions and would attract and bond with phosphorylated proteins, ones in which a phosphate group has been added to a protein activating an enzyme called kinase. Kinase, when overactive, is known to cause cancer cell formation, and many cancer drugs are aimed at inhibiting kinase activity.

"It is universal. You can detect any kind of phosphorylation in a protein," said Tao, whose findings were reported in the early online version of the journal *Analytical Chemistry*. "It is also cheaper and would be more widely available."

The nanopolymers would be added to a solution of proteins, a chemical agent to start phosphorylation and a drug to inhibit kinase activity. Phosphorylated proteins would only be present if the drug is ineffective.

Avidin-HRP -- the protein Avidin bound with the enzyme horseradish peroxidase -- would be added. Avidin would bind with a vitamin B acid called biotin that is also on the nanopolymers' surfaces. A chemical called a substrate, added later, would cause a reaction with HRP, causing the solution to change color.

A lightly colored solution would mean there had been little kinase activity and few phosphorylated proteins and that the drug was effective. A darker solution would signal more kinase activity and a less effective drug.

"This could have a lot of applications in pharmaceuticals for drug discovery," Tao said.

Screening kinase inhibitors using antibodies can be cost-prohibitive for many laboratories because antibodies are in short supply and aren't available for many types of cells. Radioisotope tests are highly regulated and possibly dangerous because of radiation involved.
"We want to develop this as a commercial application to replace radioisotopes and antibodies as a universal method for screening kinase inhibitors," Tao said.
The National Science Foundation and the National Institutes of Health funded the research.

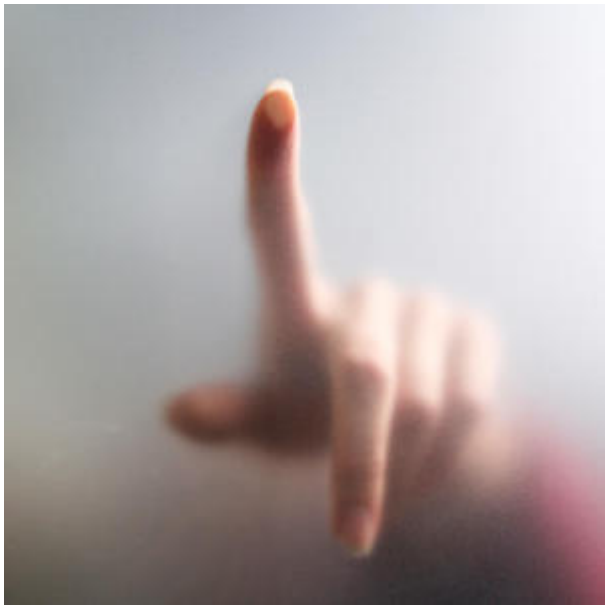
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Purdue University**. The original article was written by Brian Wallheimer.

Journal Reference:

1. Anton Iliuk, Juan S. Martinez, Mark C. Hall, W. Andy Tao. **Phosphorylation Assay Based on Multifunctionalized Soluble Nanopolymer**. *Analytical Chemistry*, 2011; : 110311102308028 DOI: 10.1021/ac2000708

http://www.sciencedaily.com/releases/2011/03/110316122516.htm

First Permanent Anti-Fog Coating Developed



Foggy glass. A new innovation could eliminate, once and for all, the fog on eyeglasses, windshields, goggles, camera lenses, and on any transparent glass or plastic surface. (Credit: iStockphoto/Chepko Danil)

ScienceDaily (Mar. 16, 2011) — Researchers under the supervision of Université Laval professor Gaétan Laroche have developed the very first permanent anti-fog coating. Dr. Laroche and his colleagues present in the online edition of Applied Materials and Interfaces the details of this innovation which could eliminate, once and for all, the fog on eyeglasses, windshields, goggles, camera lenses, and on any transparent glass or plastic surface.

Fog forms on a surface when water vapor in the air condenses in fine droplets. "Despite appearances, the fog that forms on glasses is not a continuous film. In fact, it consists of tiny droplets of water that coalesce on the surface and reduce light transmission," explains Laroche, a professor at Université Laval's Faculty of Sciences and Engineering. "A good anti-fog coating should prevent the formation of such droplets."

Researchers used polyvinyl alcohol, a hydrophilic compound that allows water to spread uniformly. The challenge was to firmly attach the compound to the glass or plastic surface. To accomplish this, researchers applied four successive layers of molecules, which formed strong bonds with their adjoining layers, prior to adding the anti-fog compound over this base. The result was a thin, transparent, multilayered coating that does not alter the optical properties of the surface on which it is overlaid. In addition, the chemical bonds that join the different layers ensure the hardness and durability of the entire coating.

"Existing anti-fog treatments don't have these properties and won't withstand washing, so the product application must be repeated regularly," notes Professor Laroche. "Our coating, on the other hand, is permanent."

Two patents already protect this invention, which has numerous potential applications, including vehicle windshields, protective visors, camera lenses, binoculars, optical instruments used in chemistry and medicine, and corrective lenses. Negotiations are already underway with a major eyewear company interested in obtaining a license for this technology.

In addition to Gaétan Laroche, the study published in *Applied Materials and Interfaces* was coauthored by Pascale Chevallier, Stéphane Turgeon, Christian Sarra-Bournet, and Raphaël Turcotte.

Story Source:

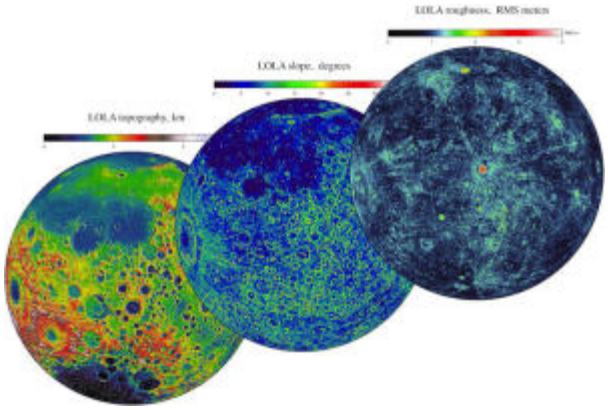
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Université Laval**.

Journal Reference:

1. Pascale Chevallier, Stéphane Turgeon, Christian Sarra-Bournet, Raphaël Turcotte, Gaétan Laroche. **Characterization of Multilayer Anti-Fog Coatings**. *ACS Applied Materials & Interfaces*, 2011; : 110307090243075 DOI: 10.1021/am1010964

http://www.sciencedaily.com/releases/2011/03/110316104117.htm

NASA's Lunar Reconnaissance Orbiter Delivers Treasure Trove of Data



LOLA data give us three complementary views of the near side of the moon: the topography (left) along with new maps of the surface slope values (middle) and the roughness of the topography (right). All three views are centered on the relatively young impact crater Tycho, with the Orientale basin on the left side. The slope magnitude indicates the steepness of terrain, while roughness indicates the presence of large blocks, both of which are important for surface operations. (Credit: NASA/LRO/LOLA Science Team)

ScienceDaily (Mar. 16, 2011) — NASA's Lunar Reconnaissance Orbiter (LRO) team released March 15, 2011 the final set of data from the mission's exploration phase along with the first measurements from its new life as a science satellite.

With this fifth release of data, striking new images and maps have been added to the already comprehensive collection of raw lunar data and high-level products, including mosaic images, that LRO has made possible. The spacecraft's seven instruments delivered more than 192 terabytes of data with an unprecedented level of detail. It would take approximately 41,000 typical DVDs to hold the new LRO data set.

"The release of such a comprehensive and rich collection of data, maps and images reinforces the tremendous success we have had with LRO in the Exploration Systems Mission Directorate and with lunar science," said Michael Wargo, chief lunar scientist of the Exploration Systems Mission Directorate at NASA Headquarters in Washington.

Among the latest products is a global map with a resolution of 100 meters per pixel from the Lunar Reconnaissance Orbiter Camera (LROC). To enhance the topography of the moon, this map was made from images collected when the sun angle was low on the horizon. Armchair astronauts can zoom in to full resolution with any of the mosaics -- quite a feat considering that each is 34,748 pixels by 34,748 pixels, or approximately 1.1 gigabytes.

"Because the moon is so close and because we have a dedicated ground station, we are able to bring back as much data from LRO as from all the other planetary missions combined," said LRO Project Scientist Richard Vondrak of NASA's Goddard Space Flight Center in Greenbelt, Md.

LRO's Diviner Lunar Radiometer Experiment is providing new data relating to the moon's surface. These include maps of visual and infrared brightness, temperature, rock abundance, nighttime soil temperature and surface mineralogy. The data are in the form of more than 1700 digital maps at a range of resolutions that can be overlaid easily on other lunar data sets.

The Lyman-Alpha Mapping Project, which collects information to help identify surface water-ice deposits, especially in permanently-shadowed regions of the moon, also has new data. This release includes new maps of far-ultraviolet (FUV) brightness, albedo and water-ice data as well as instrument exposure, illumination and other conditions.

As a complement to the high-resolution digital elevation maps, representing 3.4 billion measurements already released by the Lunar Orbiter Laser Altimeter team, the group is delivering new maps of slope, roughness and illumination conditions. New maps from the Lunar Exploration Neutron Detector, and the latest data from the

Cosmic Ray Telescope for the Effects of Radiation and the Miniature Radio Frequency instruments, also are featured.
"All these global maps and other data are available at a very high resolution -- that's what makes this release exciting," said Goddard's John Keller, the LRO deputy project scientist. "With this valuable collection, researchers worldwide are getting the best view of the moon they have ever had."
The complete data set contains the raw information and high-level products such as mosaic images and maps. The data set also includes more than 300,000 calibrated data records released by LROC. All of the final records from the exploration phase, which lasted from Sept. 15, 2009 through Sept. 15, 2010, are available through several of the Planetary Data System nodes and the LROC website.
To access LRO data, visit: http://pds.nasa.gov
LRO was built and is managed by Goddard. The exploration phase was funded by NASA's Exploration Systems Missions Directorate. LRO operates under NASA's Science Mission Directorate. For more information about LRO, visit: http://www.nasa.gov/lro

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **NASA/Goddard Space Flight Center**.

http://www.sciencedaily.com/releases/2011/03/110316084103.htm

Room-Temperature Spintronic Computers Coming Soon? Silicon Spin Transistors Heat Up and Spins Last Longer

University of Utah materials engineer Ashutosh Tiwari and doctoral student Nathan Gray have developed a way to align the magnetic "spins" of electrons within a silicon semiconductor chip at room temperature. The feat is a step toward faster, more energy efficient computers, phones and other "spintronic" devices that store data using the spin of electrons as well as their electrical charge. (Credit: Image courtesy of University of Utah)

ScienceDaily (Mar. 16, 2011) — University of Utah researchers built "spintronic" transistors and used them to align the magnetic "spins" of electrons for a record period of time in silicon chips at room temperature. The study is a step toward computers, phones and other spintronic devices that are faster and use less energy than their electronic counterparts.

"Electronic devices mostly use the charge of the electrons -- a negative charge that is moving," says Ashutosh Tiwari, an associate professor of materials science and engineering at the University of Utah. "Spintronic devices will use both the charge and the spin of the electrons. With spintronics, we want smaller, faster and more power-efficient computers and other devices."

Tiwari and Ph.D. student Nathan Gray report their creation of room-temperature, spintronic transistors on a silicon semiconductor this month in the journal *Applied Physics Letters*. The research -- in which electron "spin" aligned in a certain way was injected into silicon chips and maintained for a record 276 trillionths of a second -- was funded by the National Science Foundation.

"Almost every electronic device has silicon-based transistors in it," Gray says. "The current thrust of industry has been to make those transistors smaller and to add more of them into the same device" to process more data. He says his and Tiwari's research takes a different approach.

"Instead of just making transistors smaller and adding more of them, we make the transistors do more work at the same size because they have two different ways [electron charge and spin] to manipulate and process data," says Gray.

A Quick Spin through Spintronics

Modern computers and other electronic devices work because negatively charged electrons flow as electrical current. Transistors are switches that reduce computerized data to a binary code of ones or zeros represented by the presence or absence of electrons in semiconductors, most commonly silicon.

In addition to electric charge, electrons have another property known as spin, which is like the electron's intrinsic angular momentum. An electron's spin often is described as a bar magnet that points up or down, which also can represent ones and zeroes for computing.

Most previous research on spintronic transistors involved using optical radiation -- in the form of polarized light from lasers -- to orient the electron spins in non-silicon materials such as gallium arsenide or organic semiconductors at supercold temperatures.

"Optical methods cannot do that with silicon, which is the workhorse of the semiconductor and electronics industry, and the industry doesn't want to retool for another material," Tiwari says.
"Spintronics will become useful only if we use silicon," he adds.

The Experiment

In the new study, Tiwari and Gray used electricity and magnetic fields to inject "spin polarized carriers" -- namely, electrons with their spins aligned either all up or all down -- into silicon at room temperature.
Their trick was to use magnesium oxide as a "tunnel barrier" to get the aligned electron spins to travel from one nickel-iron electrode through the silicon semiconductor to another nickel-iron electrode. Without the magnesium oxide, the spins would get randomized almost immediately, with half up and half down, Gray says.
"This thing works at room temperature," Tiwari says. "Most of the devices in earlier studies have to be cooled to very low temperatures" -- colder than 200 below zero Fahrenheit -- to align the electrons' spins either all up or all down. "Our new way of putting spin inside the silicon does not require any cooling."
The experiment used a flat piece of silicon about 1 inch long, about 0.3 inches wide and one-fiftieth of an inch thick. An ultra-thin layer of magnesium oxide was deposited on the silicon wafer. Then, one dozen tiny transistors were deposited on the silicon wafer so they could be used to inject electrons with aligned spins into the silicon and later detect them.
Each nickel-iron transistor had three contacts or electrodes: one through which electrons with aligned spins were injected into the silicon and detected, a negative electrode and a positive electrode used to measure voltage.
During the experiment, the researchers send direct current through the spin-injector electrode and negative electrode of each transistor. The current is kept steady, and the researchers measure variations in voltage while applying a magnetic field to the apparatus
"By looking at the change in the voltage when we apply a magnetic field, we can find how much spin has been injected and the spin lifetime," Tiwari says.

A 328 Nanometer, 276 Picosecond Step for Spintronics

For spintronic devices to be practical, electrons with aligned spins need to be able to move adequate distances and retain their spin alignments for an adequate time.
During the new study, the electrons retained their spins for 276 picoseconds, or 276 trillionths of a second. And based on that lifetime, the researchers calculate the spin-aligned electrons moved through the silicon 328 nanometers, which is 328 billionths of a meter or about 13 millionths of an inch.
"It's a tiny distance for us, but in transistor technology, it is huge," Gray says. "Transistors are so small today that that's more than enough to get the electron where we need it to go."
"Those are very good numbers," Tiwari says. "These numbers are almost 10 times bigger than what we need [for spintronic devices] and two times bigger than if you use aluminum oxide" instead of the magnesium oxide in his study.
He says Dutch researchers previously were able to inject aligned spins into silicon using aluminum oxide as the "tunneling medium," but the new study shows magnesium oxide works better.
The new study's use of electronic spin injection is much more practical than using optical methods such as lasers because lasers are too big for chips in consumer electronic devices, Tiwari says.
He adds that spintronic computer processors require little power compared with electronic devices, so a battery that may power an electronic computer for eight hours might last more than 24 hours on a spintronic computer.
Gray says spintronics is "the next big step to push the limits of semiconductor technology that we see in every aspect of our lives: computers, cell phones, GPS (navigation) devices, iPods, TVs."

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

Journal Reference:

1. Nathan W. Gray, Ashutosh Tiwari. **Room temperature electrical injection and detection of spin polarized carriers in silicon using MgO tunnel barrier**. *Applied Physics Letters*, 2011; 98 (10): 102112 DOI: 10.1063/1.3564889

http://www.sciencedaily.com/releases/2011/03/110315093041.htm

Unprecedented View of Protein Folding May Help Develop Brain Disease Therapies

Biology Professor Judith Frydman and graduate student Nicholai Douglas, who was first author on the paper published in Cell. (Credit: L.A. Cicero)

ScienceDaily (Mar. 16, 2011) — When vital proteins in our bodies are misfolded, debilitating diseases can result. If researchers could see the folding happen, they might be able to design treatments for some of these diseases or even keep them from occurring. But many of our most critical proteins are folded, hidden from sight, inside tiny molecular chambers. Now researchers at Stanford have gotten the first-ever peek inside one of these protein-folding chambers as the folding happened, and the folding mechanism they saw surprised them.

Misfold an origami swan and the worst that happens is you wind up with an ugly paper duckling. Misfold one of the vital proteins in your body -- each of which must be folded in a particular way to perform its function -- and the result can be a debilitating neurodegenerative disease such as Alzheimer's or Huntington's.

There are no cures for such brain-wasting diseases, but now Stanford researchers have taken an important step that may one day aid in developing therapies for them. They have literally popped the lid off one of the microscopic chambers in which many of life's most crucial proteins are folded, witnessing a surprising mechanism as the heretofore hidden folding process happened before their eyes.

Virtually all proteins need to be folded, whether in primitive organisms such as bacteria or multicellular creatures such as humans. Many are guided through the process by molecules called chaperones, of which a specialized subset -- chaperonins -- folds many of the most complex proteins.

Folding in bacteria has been studied in detail, but Judith Frydman, a professor of biology who led the Stanford research, said this is the first time anyone has seen the folding process performed in higher organisms.

"The mechanism of folding we saw in the chaperonin is very different from what we expected and from what has been seen in bacteria," Frydman said. "It was really surprising, and we are still amazed that it worked. This chaperonin appears to provide a unique chemical environment."

Chaperonins are shaped like a barrel, with two ring-shaped chambers arranged one atop the other. At the open end of each ring is a lid that opens and closes in a spiraling fashion, like the aperture of a camera, something Frydman's team discovered in 2008 while studying the chaperonin called TRiC. Since then, they've been working to solve the puzzle of how a protein gets folded once the chaperonin has grabbed it, pulled it into the chamber and the aperture has closed. A paper describing their findings was published earlier this year in *Cell*.

Frydman said there were two likely ways in which a protein, initially a linear chain of molecules (amino acids), could theoretically be folded inside the chamber.

One is by mechanical means, with the chamber holding onto the protein and physically pushing it into the right shape.

"The other one is that when the lid closes, the chaperonin lets go of the protein, but some special chemical properties in this chamber somehow make it fold," she said. "Our evidence is that this mechanism is the correct one."

The only way to know which mechanism was doing the work was to see inside the chamber while the folding was happening, but simply opening up the lid wouldn't work, because the shape of the entire chamber changes

in accordance with the motion of the lid. When the lid spirals open, the walls of the chamber spiral open, too, and the protein floats away.
To see what was happening, Frydman's team devised a chemical "trick" by which they could remove the lid on the chamber, but still get the walls of the chamber to close in, as if the lid were spiraling.
When they "closed" the lidless chamber, the chaperonin simply released the protein that had been destined to be folded. Like a long balloon that slipped from a child's grip before it could be folded into a giraffe, the protein simply drifted off.
The challenge then became figuring out how the protein was getting released.
"One of the reasons why the mechanical model of pushing the protein into shape without letting go had been proposed was because there was no obvious way for this chaperonin to let go of the protein," Frydman said.
When a protein gets grabbed for folding by TRiC, it is held by eight binding sites along the walls of the chamber. Between each binding site is a tiny loop. Frydman's team suspected that during the closing process, the loops might move to somehow "shave off" the protein and release it into the folding chamber. One of her students made mutations in the loop. When the researchers did experiments in which TRiC chaperonins equipped with mutated loops were closed, the protein stayed put. It also failed to fold.
"That suggests that the way this chaperonin folds its proteins is by releasing them in a closed chamber that has very special chemical properties," Frydman said.
"This mechanism of release is completely different from what has been seen in any other chaperone. That was very, very surprising."
The experimental work described in the *Cell* paper was done using a simpler version of TRiC, from a single-celled organism, than would be found in multi-cellular organisms, Frydman said, because the simpler version is much easier to manipulate.
"Now we are interested in going back to the eukaryotic [multi-cellular] complex, where every binding site in the folding chamber is different and every release loop is different," Frydman said. "I think this really opens up a lot of interesting avenues to explore how this works in higher organisms. Since TRiC helps fold many disease-linked proteins, and is central to protect cells from misfolding diseases such as Huntington's disease, this work could have many therapeutic applications."

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

Journal Reference:

1. Nicholai R. Douglas, Stefanie Reissmann, Junjie Zhang, Bo Chen, Joanita Jakana, Ramya Kumar, Wah Chiu, Judith Frydman. **Dual Action of ATP Hydrolysis Couples Lid Closure to Substrate Release into the Group II Chaperonin Chamber**. *Cell*, 2011; 144 (2): 240 DOI: 10.1016/j.cell.2010.12.017

http://www.sciencedaily.com/releases/2011/03/110315163217.htm

Scientists Fly Through the Clouds to Piece Together Climate Puzzle

The WB-57 airplane can fly as high as 63,000 feet. (Credit: NASA)

ScienceDaily (Mar. 16, 2011) — As scientists try to better understand and put together the puzzle of Earth's climate, the role of clouds remains one of the most important missing pieces.

Researchers from four NASA centers, other U.S. agencies and several colleges and universities are set to participate in the Mid-latitude Airborne Cirrus Properties Experiment (MACPEX), an airborne field campaign based at Ellington Field, Texas, that aims to answer some major questions about clouds.

The campaign is scheduled to begin March 14, with science flights onboard the NASA WB-57 from March 28 to April 29.

"Initially it started as a question about the real characteristics of ice clouds in the lowest portion of the atmosphere, the upper troposphere. Past observations had shown ice particles are a lot smaller and lot more numerous than people thought they were," said Ken Jucks, Upper Atmosphere Program manager at NASA Headquarters in Washington.

"More recent measurements done at the tropics have shown that may not actually be true, but no measurements have been made at the mid-latitudes."

Energy Balance

The campaign will study the composition of cirrus clouds -- high, wispy clouds made of ice -- and their relationship to Earth's "energy budget," the combination of incoming and outgoing energy or heat.

"Recent advances in instrumentation greatly improve our ability to accurately measure the sizes and numbers of ice crystals in cirrus clouds," said MACPEX project scientist Eric Jensen of NASA's Ames Research Center in Mountain View, Calif. "This information is critically needed to evaluate and improve representations of cirrus in climate models. We anticipate that MACPEX will ultimately lead to improved accuracy of climate predictions."

In addition to Ames and Headquarters, NASA facilities involved in the campaign are the Jet Propulsion Laboratory in Pasadena, Calif., Johnson Space Center in Houston, and Langley Research Center in Hampton, Va.

"Liquid water measurements and measurements of water in its gas form will be important. We will be trying to get those observations at the same time as particle observations because we need those as well to understand cloud formation processes," Jucks said.

Langley in the Sky

MACPEX marks the first time Langley's Diode Laser Hygrometer (DLH) will fly onboard the WB-57 to measure water vapor in cirrus clouds. "This instrument usually flies on the DC-8 but the WB-57 can get up to 63,000 feet up in the air where the cirrus clouds are located," said Glenn Diskin, DLH principal investigator.

Other instruments in the WB-57 payload include Jet Propulsion Laboratory's Aircraft Laser Infrared Absorption Spectrometer (ALIAS), which will measure isotopes in water, and Chemical Ionization Mass Spectrometer (CIMS) will measure water vapor.

Science flights during the campaign are being coordinated with observations from NASA's A-Train satellites, including CALIPSO, CloudSat, Aqua, and Aura.

The A-Train is a constellation of satellites that travel one behind the other, along the same track, as they orbit Earth. By combining different sets of nearly simultaneous observations from these satellites, scientists are able to gain additional insights into the working of Earth system. During MACPEX, researchers will synchronize the flights with the A-Train to validate satellite with in situ measurements and evaluate remote-sensing measurements.

"Aircraft measurements are evolving, making it possible for us to evaluate and hopefully to lower the uncertainty in the satellite observations," said Patrick Minnis, principal investigator for the satellite component of the mission.

Campaign partners include Computer Sciences Corp. in Falls Church, Va.; University of Utah in Salt Lake City; University of Colorado at Boulder and Denver; Harvard University in Cambridge, Mass.; Bay Area Environmental Research Institute in Sonoma, Calif.; NOAA Earth System Research Laboratory in Boulder, Colo.; Spec Inc. in Boulder, Colo.; Forschungszentrum Julich in Julich, Germany; and the National Center Atmosphere Research in Boulder, Colo.

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Story Source:

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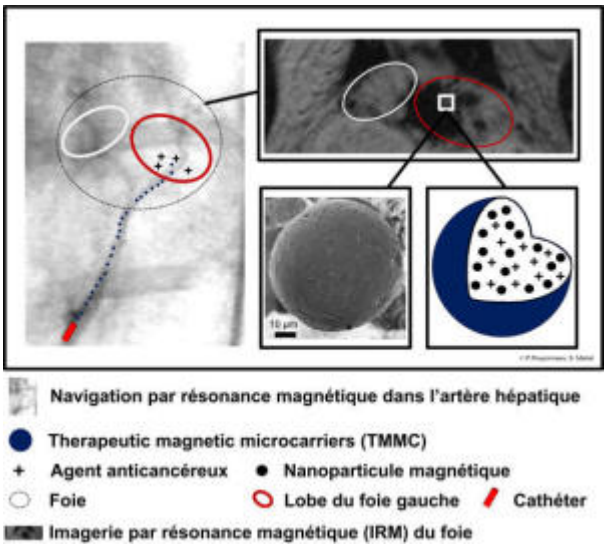
http://www.sciencedaily.com/releases/2011/03/110315142526.htm

Localized Delivery of an Anti-Cancer Drug by Remote-Controlled Microcarriers



Left: Navigation using magnetic resonance in the hepatic artery. Right: Image of liver using magnetic resonance. Key: Blue dots represent therapeutic magnetic microcarriers (TMMC); + represent anticancer agents; Red oval is part of the liver; Red bar is the catheter. (Credit: Image courtesy of Polytechnique Montréal)

ScienceDaily (Mar. 16, 2011) — Soon, drug delivery that precisely targets cancerous cells without exposing the healthy surrounding tissue to the medication's toxic effects will no longer be an oncologist's dream but a medical reality, thanks to the work of Professor Sylvain Martel, Director of the Nanorobotics Laboratory at Polytechnique Montréal.

Known for being the world's first researcher to have guided a magnetic sphere through a living artery, Professor Martel is announcing a new breakthrough in the field of nanomedicine. Using a magnetic resonance imaging (MRI) system, his team successfully guided microcarriers loaded with a dose of anti-cancer drug through the bloodstream of a living rabbit, right up to a targeted area in the liver, where the drug was successfully administered. This is a medical first that will help improve chemoembolization, a current treatment for liver cancer.

Microcarriers on a mission

The therapeutic magnetic microcarriers (TMMCs) were developed by Pierre Pouponneau, a PhD candidate under the joint direction of Professors Jean-Christophe Leroux and Martel. These tiny drug-delivery agents, made from biodegradable polymer and measuring 50 micrometers in diameter -- just under the breadth of a hair -- encapsulate a dose of a therapeutic agent (in this case, doxorubicin) as well as magnetic nanoparticles. Essentially tiny magnets, the nanoparticles are what allow the upgraded MRI system to guide the microcarriers through the blood vessels to the targeted organ. During the experiments, the TMMCs injected into the bloodstream were guided through the hepatic artery to the targeted part of the liver where the drug was progressively released.

The results of these in-vivo experiments have recently been published in the journal *Biomaterials* and the patent describing this technology has just been issued in the United States.

Story Source:

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

Journal Reference:

1. Pierre Pouponneau, Jean-Christophe Leroux, Gilles Soulez, Louis Gaboury, Sylvain Martel. **Co-encapsulation of magnetic nanoparticles and doxorubicin into biodegradable microcarriers for deep**

tissue targeting by vascular MRI navigation. *Biomaterials*, 2011; 32 (13): 3481 DOI: 10.1016/j.biomaterials.2010.12.059

http://www.sciencedaily.com/releases/2011/03/110316084417.htm

Paleontologists Audition Modern Examples of Ancient Behavior

Fossil brachiopod from the Oslo, Norway region. (Credit: iStockphoto)

ScienceDaily (Mar. 16, 2011) — Paleontologists agree that it's difficult to observe behavior in fossil specimens that are dead -- even extinct -- and petrified. One method is to find a modern, living, species that has some similarities to the ancient animal.

That's the strategy adopted by David L. Meyer, University of Cincinnati professor of geology and colleagues as they study a group of ancient shellfish known as brachiopods. Although they resemble clams or other shelled mollusks, brachiopods are more closely related to marine worms. Relatively rare today, brachiopods were a dominant species in Paleozoic seas.

In the fossil-rich rocks of the Cincinnati region, a group of brachiopods known as strophomenates are found fossilized surrounded by tiny "moats." It is believed that the brachiopods themselves made the moats, but it is not certain how they did so. Paleontologists think the animals needed to open their shells to a gape of more than 45 degrees to make the moats.

Meyer, along with Benjamin Dattilo of Indiana University Purdue University Fort Wayne (a Ph.D. graduate of UC's geology program), and two students went looking for a modern analogue to the Paleozoic brachiopods. They found a tiny modern brachiopod named Thecidellina meyeri in the waters off Curaçao in the southern Caribbean.

"It's a reasonably good analogue," Meyer said. "They gape widely, and the internal anatomy shows similar structures."

Meyer, Dattilo, and UC students Tanya Del Valle and Christine Rahtz collected a fragment of coral covered with more than 30 Thecidellina specimens, and placed it in a tank with running seawater in the lab in Curaçao.

"They rapidly recovered," Meyer said, "resumed normal feeding behaviors, and maintained a 90-degree gape."

With video cameras recording, the paleontologists measured the ability of the modern brachiopods to move water around, generating relatively sluggish feeding currents and relatively strong currents when they snapped their shells shut.

Sometimes, the brachiopods would snap shut, stay shut, and then slowly open. At other times, they would open partially and shut several times in rapid succession.

The behavior of the modern animals provides a clue to ancient behaviors.

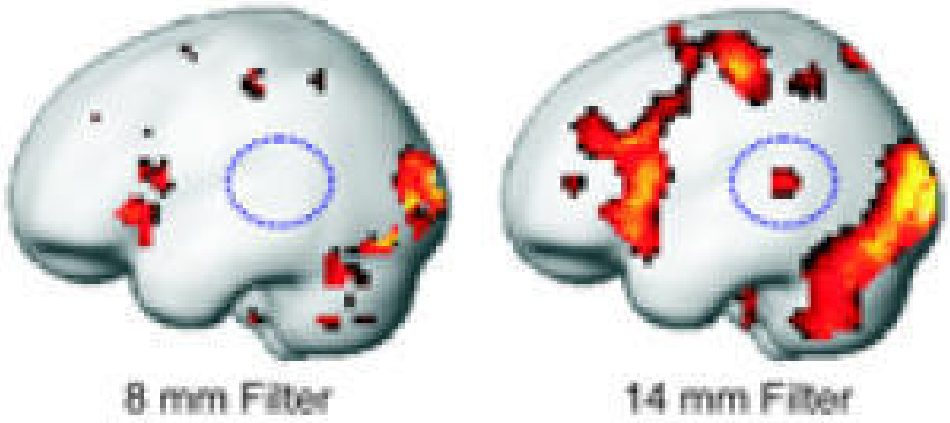
"By analogy," Meyer said, "feeding currents of the ancient brachiopods were too weak to disturb sediments, allowing them to feed close to the sea floor."

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of Cincinnati**, via EurekAlert!, a service of AAAS.

http://www.sciencedaily.com/releases/2011/03/110316142628.htm

How Clear Is Our View of Brain Activity?



Interfering filters: In the identical original data set, a region of the brain (circled) appears active in one case, but not in the other – solely dependent on the "mesh size" of the used data filter. (Credit: Image courtesy of Albert-Ludwigs-Universität Freiburg)

ScienceDaily (Mar. 16, 2011) — Imaging techniques have become an integral part of the neurosciences. Methods that enable us to look through the human skull and right into the active brain have become an important tool for research and medical diagnosis alike. However, the underlying data have to be processed in elaborate ways before a colourful image informs us about brain activity.

Scientists from Freiburg and colleagues were now able to demonstrate how the use of different filters may influence the resulting images and lead to contradicting conclusions.

In the current issue of *Human Brain Mapping*, Tonio Ball of the Bernstein Center Freiburg and colleagues from the universities of Oldenburg, Basel and Magdeburg demonstrate how variable the results of imaging techniques like functional Magnetic Resonance Imaging (fMRI) can be -- depending on the way how the original data are filtered. The use of filtering algorithms is indispensable in order to separate meaningful information from inherent noise that is part of every data set. These filters have different "mesh sizes" or widths, and are indispensable in the first place to reveal activity patterns that span different scale sizes. In most cases, only a filter of one specific width, which differs from study to study, is employed.

Tonio Ball and colleagues systematically investigated the influence of the mesh size of these filters on the resulting imagery of brain activity. They conducted an experiment during which test persons had to rate music by pressing a button while lying in an fMRI scanner. During this task, brain regions responsible for hearing, vision, and arm movements were active. The scientists treated the gained data with filters of different widths and found surprising results: The filters had a marked influence on the outcome of the brain scan analyses, showing increased brain activity in one region in one case, and in a different region -- in the other. Even smallest changes in filter width led to areas of the brain appearing to be either active or inactive. This effect can ultimately lead to widely disparate interpretations of such a scan.

Tonio Ball and his colleagues therefore stress the importance of taking into account the effect of filtering in future interpretations of fMRI studies. This way, scientists won't run the risk of inadvertently skewing our view of the brain.

Story Source:

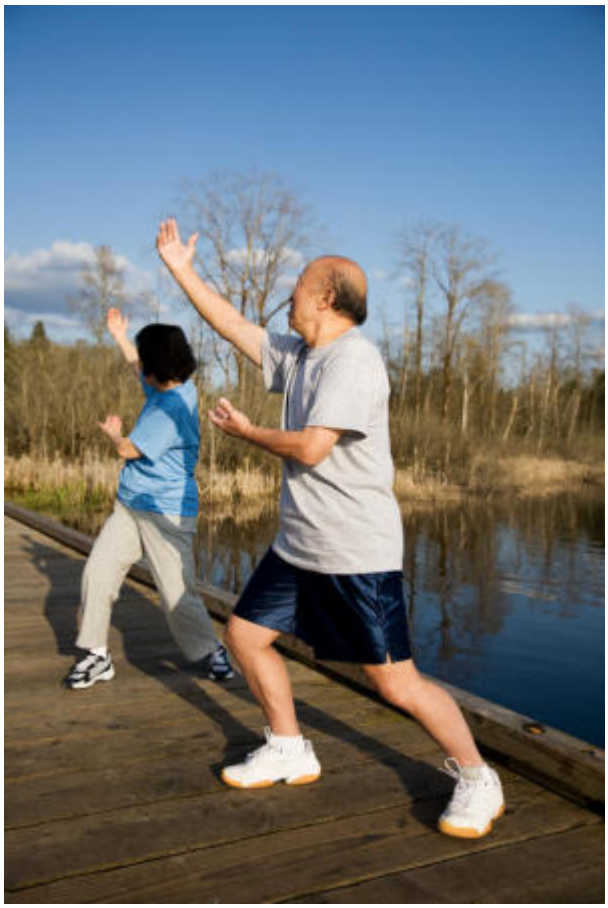
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Albert-Ludwigs-Universität Freiburg**.

Journal Reference:

1. Tonio Ball, Thomas P.K. Breckel, Isabella Mutschler, Ad Aertsen, Andreas Schulze-Bonhage, Jürgen Hennig, Oliver Speck. **Variability of fMRI-response patterns at different spatial observation scales**. *Human Brain Mapping*, 2011; DOI: 10.1002/hbm.21274

http://www.sciencedaily.com/releases/2011/03/110316134605.htm

Tai Chi Beats Back Depression in the Elderly, Study Shows



People practicing tai chi. When researchers combined a weekly tai chi exercise class with a standard depression treatment for a group of depressed elderly adults, they found greater improvement in the level of depression -- along with improved quality of life, better memory and cognition, and more overall energy -- than among a different group in which the standard treatment was paired with a weekly health education class. (Credit: iStockphoto/Suprijono Suharjoto)

ScienceDaily (Mar. 16, 2011) — The numbers are, well, depressing: More than 2 million people age 65 and older suffer from depression, including 50 percent of those living in nursing homes. The suicide rate among white men over 85 is the highest in the country -- six times the national rate.

And we're not getting any younger. In the next 35 years, the number of Americans over 65 will double and the number of those over 85 will triple.

So the question becomes, how to help elderly depressed individuals?

Researchers at UCLA turned to a gentle, Westernized version of tai chi chih, a 2,000-year-old Chinese martial art. When they combined a weekly tai chi exercise class with a standard depression treatment for a group of depressed elderly adults, they found greater improvement in the level of depression -- along with improved quality of life, better memory and cognition, and more overall energy -- than among a different group in which the standard treatment was paired with a weekly health education class.

The results of the study appear in the current online edition of the *American Journal of Geriatric Psychiatry*.

"This is the first study to demonstrate the benefits of tai chi in the management of late-life depression, and we were encouraged by the results," said first author Dr. Helen Lavretsky, a UCLA professor-in-residence of psychiatry. "We know that nearly two-thirds of elderly patients who seek treatment for their depression fail to achieve relief with a prescribed medication."

In the study, 112 adults age 60 or older with major depression were treated with the drug escitalopram, a standard antidepressant, for approximately four weeks. From among those participants, 73 who showed only partial improvement continued to receive the medication daily but were also randomly assigned to 10 weeks of either a tai chi class for two hours per week or a health education class for two hours per week.
All the participants were evaluated for their levels of depression, anxiety, resilience, health-related quality of life, cognition and immune system inflammation at the beginning of the study and again four months later.
The level of depression among each participant was assessed using a common diagnostic tool known as the Hamilton Rating Scale for Depression, which involves interviewing the individual. The questions are designed to gauge the severity of depression. A cut-off score of 10/11 is generally regarded as appropriate for the diagnosis of depression.
The researchers found that among the tai chi participants, 94 percent achieved a score of less than 10, with 65 percent achieving remission (a score of 6 or less). By comparison, among participants who received health education, 77 percent achieved scores of 10 or less, with 51 percent achieving remission.
While both groups showed improvement in the severity of depression, said Lavretsky, who directs UCLA's Late-Life Depression, Stress and Wellness Research Program, greater reductions were seen among those taking escitalopram and participating in tai chi, a form of exercise that is gentle enough for the elderly.
"Depression can lead to serious consequences, including greater morbidity, disability, mortality and increased cost of care," Lavretsky said. "This study shows that adding a mind-body exercise like tai chi that is widely available in the community can improve the outcomes of treating depression in older adults, who may also have other, co-existing medical conditions, or cognitive impairment.
"With tai chi," she said, "we may be able to treat these conditions without exposing them to additional medications."
Other authors on the study included Lily L. Alstein, Richard E. Olmstead, Linda M. Ercoli, Marquertie Riparetti-Brown, Natalie St. Cyr and Michael R. Irwin, all of UCLA.
Funding for the study was provided by the National Institutes of Health, the General Clinical Research Centers Program, the UCLA Cousins Center at the Semel Institute for Neuroscience and Human Behavior, and the UCLA Older Americans Independence Center.

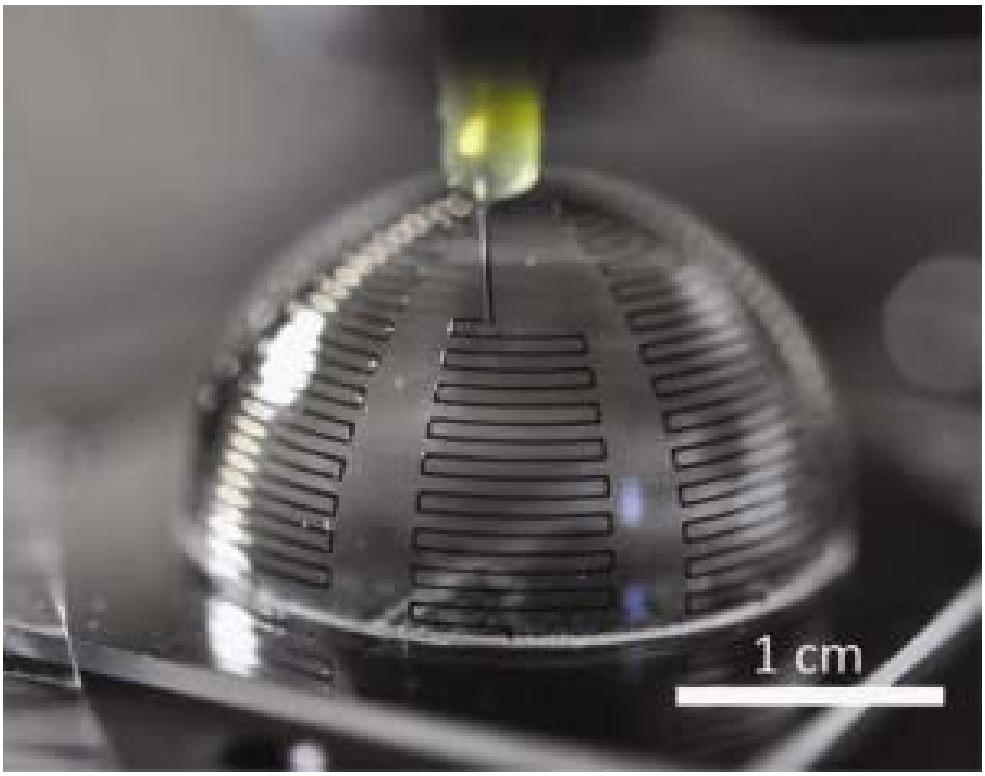
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of California - Los Angeles**. The original article was written by Mark Wheeler.

Journal Reference:

1. Helen Lavretsky, Lily L. Alstein, Richard E. Olmstead, Linda M. Ercoli, Marquertie Riparetti-Brown, Natalie St. Cyr, Michael R. Irwin. **Complementary Use of Tai Chi Chih Augments Escitalopram Treatment of Geriatric Depression**. *American Journal of Geriatric Psychiatry*, 2011; : 1 DOI: 10.1097/JGP.0b013e31820ee9ef

http://www.sciencedaily.com/releases/2011/03/110316131122.htm

3-D Printing Method Advances Electrically Small Antenna Design



Optical image of an antenna during the printing process. (Credit: Image courtesy of University of Illinois College of Engineering)

ScienceDaily (Mar. 16, 2011) — While most electronic components benefit from decreased size, antennas -- whether in a cell phone or on an aircraft -- suffer limitations in gain, efficiency, system range, and bandwidth when their size is reduced below a quarter-wavelength.

"Recent attention has been directed toward producing antennas by screen-printing, inkjet printing, and liquid metal-filled microfluidics in simple motifs, such as dipoles and loops," explained Jennifer T. Bernhard, a professor of electrical and computer engineering at Illinois. "However, these fabrication techniques are limited in both spatial resolution and dimensionality, yielding planar antennas that occupy a large area relative to the achieved performance."

"Omnidirectional printing of metallic nanoparticle inks offers an attractive alternative for meeting the demanding form factors of 3D electrically small antennas (ESAs)," stated Jennifer A. Lewis, the Hans Thurnauer Professor of Materials Science and Engineering and director of the Frederick Seitz Materials Research Laboratory at Illinois.

"To our knowledge, this is the first demonstration of 3D printed antennas on curvilinear surfaces," Lewis stated. The research findings and fabrication methods developed by Bernhard, Lewis, and their colleagues are featured in the cover article, "Illinois Calling" of the March 18 issue of Advanced Materials.

According to Bernhard, these antennas are electrically small relative to a wavelength (typically a twelfth of a wavelength or less) and exhibit performance metrics that are an order of magnitude better than those realized by monopole antenna designs.

"There has been a long-standing problem of minimizing the ratio of energy stored to energy radiated -- the Q -- of an ESA," Bernhard explained. "By printing directly on the hemispherical substrate, we have a highly versatile single-mode antenna with a Q that very closely approaches the fundamental limit dictated by physics (known as the Chu limit).

Conformal printing allows the antenna's meander lines to be printed on the outside or inside of hemispherical substrates, adding to its flexibility.

"Unlike planar substrates, the surface normal is constantly changing on curvilinear surfaces, which presents added fabrication challenges," Lewis noted. To conformally print features on hemispherical substrates, the silver ink must strongly wet the surface to facilitate patterning even when the deposition nozzle (100 μm diameter) is perpendicular to the printing surface.
To fabricate an antenna that can withstand mechanical handling, for example, the silver nanoparticle ink is printed on the interior surface of glass hemispheres. Other non-spherical ESAs can be designed and printed using a similar approach to enable integration of low Q antennas on, for example, the inside of a cell phone case or the wing of an unmanned aerial vehicle. The antenna's operating frequency is determined primarily by the printed conductor cross-section and the spacing (or pitch) between meander lines within each arm. According to the researchers, their design can be rapidly adapted to new specifications, including other operating frequencies, device sizes, or encapsulated designs that offer enhanced mechanical robustness. "This conformal printing technique can be extended other potential applications, including flexible, implantable, and wearable antennas, electronics, and sensors," Lewis said.

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

Journal Reference:

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Multi-Tasking on the Street Not a Good Idea for Older People

Postdoctoral researcher and study co-author Mark Neider demonstrates the simulated street scene and multi-directional treadmill used in the study. (Credit: L. Brian Stauffer)

ScienceDaily (Mar. 16, 2011) — Older adults may put themselves at risk by talking on cell phones while crossing the street, researchers report in a new study. The researchers found that adults aged 59 to 81 took significantly longer than college students to cross a simulated street while talking on a mobile phone, and their heightened cautiousness in initiating crossing did nothing to improve their safety. Older adults on cell phones also were more likely to fail to cross in the time allotted for the task.

The findings, from researchers at the University of Illinois, appear in the journal *Psychology and Aging*.

In the study, 18 undergraduate students (aged 18 to 26 years) and 18 older adults crossed simulated streets of varying difficulty while either undistracted, listening to music or conversing on a hands-free cell phone. The older adults were significantly impaired on the most challenging street-crossing tasks while also engaged in a second activity, with the most pronounced impairment occurring during cell phone conversations. The younger adults showed no impairment on dual-task performance, the researchers found.

"It should be noted that we have previously found that younger adults show similar performance decrements, but under much more challenging crossing conditions," said lead author Mark Neider, a postdoctoral researcher who conducted the study with Illinois psychology professor and Beckman Institute director Art Kramer.

"Combined with our previous work, the current findings suggest that while all pedestrians should exercise caution when attempting to cross a street while conversing on a cell phone, older adults should be particularly careful," Neider said

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of Illinois at Urbana-Champaign**.

Journal Reference:

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Optical Illusions Show Vision in a New Light

Greek columns of Propylaea Gate, the entrance to the Parthenon on Acropolis Hill in Athens. (Credit: iStockphoto/Aleksandar Nakic)

ScienceDaily (Mar. 15, 2011) — Optical illusions have fascinated humans throughout history. Greek builders used an optical illusion to ensure that that their columns appeared straight (they built them with a bulge) and we are all intrigued by the mental flip involved in the case of the young girl/old woman faces.

New research published in BioMed Central's open access journal *BMC Neuroscience* demonstrates a more serious use of these illusions in understanding how the brain assesses relative size.

Researchers from University College London looked at two well known illusions: the Ebbinghaus illusion, where an object surrounded by small circles appears bigger than the same object surrounded by bigger circles, and the Ponzo illusion, where an object within converging lines (like train tracks or a corridor) is perceived to be larger than a same sized object nearer to the observer.

Their results show that the Ponzo illusion holds true regardless of which eye is used or whether the environmental clues are presented to a different eye than the objects. This suggests that our clues about relative size at a distance are determined after the two-dimensional images seen by the eyes have been processed into a single, three-dimensional, image. In contrast the Ebbinghaus illusion does not work as well if the central object is presented to a different eye than the surrounding circles and shows that determination of an object's size relative to others in the same plane occurs before three-dimension processing.

Chen Song said, "Although our perception of size is distorted by environmental clues, this study shows that the extent of distortion and the brain mechanisms involved are dependent on the type of environmental contexts."

So while celebrity illusionists retain their ability to fool us, scientists can use these visual tricks to further our understanding of how we relate to the world around us -- and have some fun at the same time.

Story Source:

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

Journal Reference:

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Bilinguals See the World in a Different Way, Study Suggests

Colour perception is an ideal way of testing bilingual concepts because there is a huge variation between where different languages place boundaries on the colour spectrum. (Credit: iStockphoto)

ScienceDaily (Mar. 15, 2011) — Learning a foreign language literally changes the way we see the world, according to new research. Panos Athanasopoulos, of Newcastle University, has found that bilingual speakers think differently to those who only use one language.

And you don't need to be fluent in the language to feel the effects -- his research showed that it is language use, not proficiency, which makes the difference.

Working with both Japanese and English speakers, he looked at their language use and proficiency, along with the length of time they had been in the country, and matched this against how they perceived the colour blue.

Colour perception is an ideal way of testing bilingual concepts because there is a huge variation between where different languages place boundaries on the colour spectrum.

In Japanese, for example, there are additional basic terms for light blue (mizuiro) and dark blue (ao) which are not found in English.

Previous research has shown that people are more likely to rate two colours to be more similar if they belong to the same linguistic category.

"We found that people who only speak Japanese distinguished more between light and dark blue than English speakers," said Dr Athanasopoulos, whose research is published in the current edition of *Bilingualism: Language and Cognition*. "The degree to which Japanese-English bilinguals resembled either norm depended on which of their two languages they used more frequently."

Most people tend to focus on how to do things such as order food or use public transport when they learn another language to help them get by, but this research has shown that there is a much deeper connection going on.

"As well as learning vocabulary and grammar you're also unconsciously learning a whole new way of seeing the world," said Dr Athanasopoulos. "There's an inextricable link between language, culture and cognition. "If you're learning language in a classroom you are trying to achieve something specific, but when you're immersed in the culture and speaking it, you're thinking in a completely different way."

He added that learning a second language gives businesses a unique insight into the people they are trading with, suggesting that EU relations could be dramatically improved if we all took the time to learn a little of each other's language rather than relying on English as the lingua-franca.

"If anyone needs to be motivated to learn a new language they should consider the international factor," he said. "The benefits you gain are not just being able to converse in their language -- it also gives you a valuable insight into their culture and how they think, which gives you a distinct business advantage.
"It can also enable you to understand your own language better and gives you the opportunity to reflect on your own culture, added Dr Athanasopoulos, who speaks both Greek and English.

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

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Mini Disks for Data Storage: Slanted Edges Favor Tiny Magnetic Vortices

Slanted exterior edges allow tiniest magnetic vortices on nano disks, one disk having a diameter of 150 nanometers. Each vortice is directed either upwards or downwards. Together with the direction of the magnetic rotation each magnetic disk can take four different states on the smallest space. (Credit: S. Münster, Kunstkosmos)

ScienceDaily (Mar. 15, 2011) — Slanted exterior edges on tiny magnetic disks could lead to a breakthrough in data processing. "By this, structures are created which were impossible in the past;" explains Jeffrey McCord, a materials researcher at the Helmholtz-Zentrum Dresden-Rossendorf. The doctoral candidate Norbert Martin produced the slanted edges in a lab experiment; thus, creating magnetic vortices with a diameter of only one third of a thousandth of a millimeter. This could help to store larger amounts of data on increasingly smaller surfaces with as little energy as possible.

Tiny magnets organize themselves in vortices in the researchers' mini disks. The individual magnets can twist either in a clockwise or a counterclockwise direction in the disk. These two different states can be used in data processing just like switching the electricity "on" and "off" in conventional computers. In contrast to conventional memory storage systems, these magnetic vortices can be switched by the electrons' intrinsic spin and with far less power consumption.

In the exterior section of a vortex the magnetic particles align nearly parallel to one another while the space in the disk's center is insufficient for such a parallel arrangement. Therefore, the elementary magnets in the center of a vortex twist away from the surface of the disk in order to gain space and thus, orient themselves once again next to one another without consuming much energy.

The formation of a vortex only works smoothly if the individual magnetic disks maintain some distance to one another or are relatively big. In order to achieve a high data storage density for compact and efficient devices, manufacturers and users ask for the smallest possible data processing units, which in turn also feature small magnetic vortices and require a closely packed structure. Then, however, the tiny magnets in each disk

"feel" their neighbors in the adjacent disks and start to interact. This interaction, though, is a poor prerequisite for memory storage systems.
Therefore Norbert Martin and Jeffrey McCord eliminated the cylindrical shape of the small magnetic disks and instead prepared them with slanted edges. The tiny magnets at the edges are thus forced in the direction of the slant. This orientation creates in turn a magnetic field perpendicular to the disk surface, which then is in the preferred direction of the slant. This requires a lot less energy than the symmetric orientation of this magnetic field for the disks with vertical outer edges. Accordingly, magnetic vortices form more easily with slanted edges.
To create these vortices, Norbert Martin places tiny glass spheres with a diameter of 0.30 thousandth of a millimeter (300 nanometers) on top of a thin magnetic layer. Under specific conditions, all of these glass spheres arrange next to each other and therefore form a mask of tiny hexagons with small gaps. When the scientists direct argon ions at this layer, these atomic and electrically charged projectiles penetrate the gaps between the glass spheres and force particles out of the magnetic layer located under the gaps. The array of the glass spheres, thus, functions as a mask: One magnetic disk remains below each individual glass sphere, while the magnetic layer under the gaps erodes. During the bombardment, though, the argon ions remove material from the glass spheres which, according to that, continuously decrease in size. At the end of the process the diameter of the glass spheres is only 260 nanometers, instead of the original 300 nanometers. This permits the argon ions to reach also areas which are located further inside the magnetic disks that are emerging beneath the glass spheres over time. Because the time of bombardment is shorter in these places, less material is removed on the inside. The desired slanted edge is therefore created virtually on its own.
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Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Helmholtz Association of German Research Centres**. The original article was written by Roland Knauer.

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Slow evolvers win in the end
In bacterial populations, speed kills.
Joseph Milton

Slowly evolving bacteria eventually outcompete their quicker colleagues.Ashway / Alamy

In Aesop's fable about the tortoise's victory over the hare, a slow, steady approach trumps a fast and impulsive one. And when it comes to evolution — for bacteria, at any rate — a leisurely pace may also be the best strategy for long-term survival.

Research carried out in Richard Lenski's lab at Michigan State University in East Lansing, and published today in Science [1], shows that rapidly evolving 'hare' bacteria were eventually wiped out by their more sluggish rivals.

The reason was that the 'tortoise' bacteria had a higher 'evolvability', or a greater potential to take advantage of future beneficial mutations, than their speedier competitors, despite a tendency to accumulate such mutations at a slower rate.

Long haul

"It all depends how long the race is," says Tim Cooper, an evolutionary biologist at the University of Houston in Texas, a co-author on the study. "Tortoises don't win over 100 metres but they might win a marathon."

Cooper and his colleagues looked at two Escherichia coli clone lineages, sampled after 500, 1,000 and 1,500 generations of evolution. They came from a long-term bacterial evolution experiment running in the lab.

By looking for the presence of five beneficial mutations, the researchers found that 'hare' bacteria had more advantageous genetic changes than 'tortoises' after 500 generations, suggesting they were more likely to go on to successfully survive and reproduce, and to eventually wipe out their competitors altogether.

But looking at the later generations, the team found that 'tortoises' had overtaken 'hares' and gone on to dominate the population.

Importantly, by the 500th generation both bacterial lineages had acquired beneficial mutations in a gene involved in coiling up DNA to fit into cell nuclei called topA, but these mutations differed slightly between the two.

The E. coli were then allowed to evolve for a further 883 generations, and the team looked to see which mutations had accumulated by that point. This time they found a mutation in a gene called spoT, conferring an advantage to the 'tortoises' that was absent in the 'hares'.

But the previous topA mutation in the 'hares' had rendered the potentially beneficial spoT mutation useless, because of interactions between genes.

Late domination

The advantage conferred by spoT meant the 'tortoises' were now fitter than the 'hares', explaining why they went on to dominate the population.
"It's exciting because it was generally thought that an increased mutation rate meant you were more evolvable," says Daniel Rozen, an evolutionary biologist at the University of Manchester, UK. "This shows genetic background is another really important aspect of evolvability."

However, Ed Feil, an evolutionary biologist at the University of Bath, UK, is more sceptical. "I'm not sure they've shown selection for evolvability," he says, adding that he thinks the tortoises may have been fitter all along. "It's hard to explain why the 'hares' are fitter at 500 generations — the topA mutation actually confers higher fitness to the 'tortoises', and that's one of just two mutations we know about."
But Cooper is confident the fitness calculations are accurate, and says there are other mutations in play by the 500-generation point. "The 'hares' have at least four mutations," he says, "It's the whole package that makes them fitter, not just topA."
The next step, says Cooper, is to look more closely at exactly why the 'hare' topA mutation interferes with spoT, and to investigate practical applications of their findings. "In an industrial setting we could encourage evolvability to get bacteria that reach higher end-points," he says, "and in a clinical setting we could discourage it so we end up with bacteria that are easier to treat."

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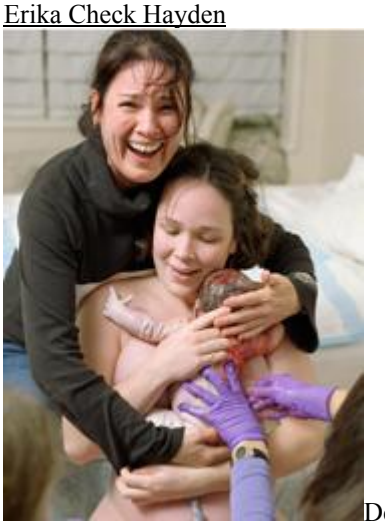
Home-birth study investigated

Criticism led journal to re-examine controversial paper that found higher death rate in babies born at home.

Erika Check Hayden



Debate over paper on the safety of home birth highlights difficulty of conducting research on the topic.Ocean/Corbis

The 25,000 US women who give birth at home each year received shocking news from the nation's obstetricians early this year. Babies born at home die within their first month of life at two to three times the rate of children born in hospitals, the American Congress of Obstetricians and Gynecologists (ACOG) declared on the basis of a review[1] published in July 2010.

But the study behind the warning is not as definitive as it seemed. Before the ACOG warning, the study generated so much criticism that the journal that published it, the American Journal of Obstetrics & Gynecology, was investigating it. The post-publication review documented errors in the original analysis, but it did not contradict the study or change the paper's conclusions, and the problems do not warrant a retraction, according to Elsevier in New York, the company that publishes the journal.

The ongoing debate over the study underscores the difficulty of conducting objective reviews on controversial medical topics such as home birth, says Andrew Vickers, a statistician at the Memorial Sloan-Kettering Cancer Center in New York.

"The scientific debate about home birth has become extremely polarized and politicized," Vickers says. "It is becoming hard to be anything but sceptical about anything but the most carefully conducted randomized trials."

The home-birth study was published last July by Joseph Wax, a specialist in maternal fetal medicine at the Maine Medical Center in Portland and his colleagues, who conducted a meta-analysis of 12 studies on home and hospital births. Using data from a subset of four of these studies, Wax's team concluded that babies born at home without birth defects were more likely to die in their first 28 days of life than those born in hospitals.

Soon after the study came out, epidemiologists, nurses, midwives, some obstetricians and home-birth advocates alleged that the paper did not meet standards set out in internationally recognized systems promoting best practice in conducting and reporting meta-analyses, such as the Cochrane Collaboration's Cochrane Reviews for evidence-based healthcare and the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) Statement.

Divergent methods

Researchers had also identified potential errors in the study's statistics. For instance, Carl Michal, a physicist at the University of British Columbia in Vancouver, Canada, identified an error in an online meta-analysis calculator used by Wax's team to arrive at some of its conclusions. The developer of that calculator acknowledged the error and has alerted potential users to the problem.

And Karin Michels, an epidemiologist at Harvard Medical School in Boston, Massachusetts, points out that Wax's team did not provide measurements of the variations between the studies included in its analysis; when studies diverge widely in methods and outcomes, they should not be combined, Michels says. As a result, she

says, readers can't know how much the studies included may differ and whether it was appropriate to combine them.

In a statement sent to Nature, Elsevier says that in response to the criticisms, the journal enlisted three "specialists in maternal fetal medicine with expertise in meta-analysis and clinical research" to examine all the correspondence that the journal had received regarding the Wax paper. The reviewers attempted to reconstruct Wax's calculated risks for three outcomes: deaths of neonates, or infants from birth to 28 days old; premature births before 37 weeks of gestation; and 'postmature' births after 42 weeks of gestation, according to Elsevier. Postmaturity can carry risks such as diminished amniotic fluid. "In all 3 cases, the results the panel found were slightly different from that in the Wax paper," says Elsevier, although the panel did not find major differences in the risk estimates or the overall statistical significance of the results.

The review committee recommended that the journal publish full summary graphs online for each outcome in the study, "which will allow readers to better assess the study findings", says Elsevier. But the committee did not recommend a retraction of Wax's paper by the journal. "There were a number of issues raised in the letters, many of which the panel felt were subjective and should be debated openly," Elsevier told Nature.

On 28 February, Wax's team posted the requested summary graphs on the journal website. The risk of newborn death and postmaturity among babies born at home is now higher than it was in the original paper, and the risk of prematurity is now lower. The document does not discuss whether or how Wax's group erred in its original calculations, or what changes were made to produce the new results.

Controversial exclusion

Critics are not appeased, because many had argued that Wax's team erred by inappropriately including or excluding studies from some of these outcomes in the first place. Epidemiologists consulted by Nature, who are not involved in the home-birth debate, agreed that there were problems with the study design.

Diana Petitti, an epidemiologist at the Arizona State University Center for Health Information and Research in Phoenix who authored a book on meta-analysis, says Wax's group should not have excluded data from a major Dutch study, published in 2009, that examined more than 300,000 home births for many outcomes, including the risk of newborn deaths. That study found no increased risk of death after home birth in the first week of life.

Petitti says this issue could have led to incorrect conclusions even if the statistical methods were sound. "The problem of excluding the Netherlands study dwarfs any problem related to software or the statistical models," she says.

ACOG and Wax declined multiple requests from Nature for comment. But the journal will publish more letters regarding the study and responses from Wax in coming weeks.

Elsevier says the journal did not notify ACOG about the investigation of Wax's study. Nonetheless, the substantial public criticisms of the paper should have given ACOG "some reservations" about using the study in its statement about home births, said David Moher, a clinical epidemiologist at the University of Ottawa and chair of the PRISMA Statement.

But, Moher says, it is unfortunately common for reviews to contain major methodological flaws.

"The quality of non-Cochrane Reviews leaves much to be desired," he says.

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http://www.nature.com/news/2011/110318/full/news.2011.162.html

Music is all in the mind

A brain–computer interface allows paralysed patients to play music with brainpower alone.

Philip Ball

The brain-computer interface allows paralysed patients to play music just by thinking about it.ICCMR Research Team - University of Plymouth

A pianist plays a series of notes, and the woman echoes them on a computerized music system. The woman then goes on to play a simple improvised melody over a looped backing track. It doesn't sound like much of a musical challenge — except that the woman is paralysed after a stroke, and can make only eye, facial and slight head movements. She is making the music purely by thinking.

This is a trial of a computer-music system that interacts directly with the user's brain, by picking up the tiny electrical impulses of neurons. The device, developed by composer and computer-music specialist Eduardo Miranda of the University of Plymouth, UK, working with computer scientists at the University of Essex, should eventually help people with severe physical disabilities, caused by brain or spinal-cord injuries, for example, to make music for recreational or therapeutic purposes. The findings are published online in the journal Music and Medicine[1].

"This is an interesting avenue, and might be very useful for patients," says Rainer Goebel, a neuroscientist at Maastricht University in the Netherlands who works on brain-computer interfacing.

Therapeutic use

Evidence suggests that musical participation can be beneficial for people with neurodegenerative diseases such as dementia and Parkinson's disease. But people who have almost no muscle movement have generally been excluded from such benefits, and can enjoy music only through passive listening.

The development of brain–computer interfaces (BCIs) that enable users to control computer functions by mind alone offer new possibilities for such people (see Mental ping-pong could aid paraplegics). In general, these interfaces rely on the user's ability to learn how to self-induce particular mental states that can be detected by brain-scanning technologies.

Miranda and his colleagues have used one of the oldest of these systems: electroencephalography (EEG), in which electrodes on the skull pick up faint neural signals. The EEG signal can be processed quickly, allowing fast response times, and the instrument is cheaper and more portable than brain-scanning techniques such as magnetic resonance imaging and positron-emission tomography.

Previous efforts using BCIs have focused on moving computer screen icons such as cursors, but Miranda's team sought to achieve the much more complex task of enabling users to play and compose music. Miranda says that he first became aware of the then-emerging field of BCIs more than a decade ago while researching how to make music using brainwaves. "When I realized the potential of a musical BCI for the wellbeing of severely disabled people," he says, "I couldn't leave the idea alone. Now I can't separate this work from my activities as a composer."

The trick is to teach the user how to associate particular brain signals with specific tasks by presenting a repeating stimulus — auditory, visual or tactile — and getting the user to focus on it. This elicits a distinctive, detectable pattern in the EEG signal. Miranda and his colleagues show several flashing 'buttons' on a computer screen, which each trigger a musical event. The users push a button just by directing their attention to it.

For example, a button could be used to generate a melody from a preselected set of notes. The user can alter the intensity of the control signal – how 'hard' the button is pressed – by varying the intensity of attention, and the result is fed back to them visually as a change in the button's size. In this way, any one of several notes can be selected by mentally altering the intensity of pressing.
With a little practice, this allows users to create a melody as if they were selecting keys on a piano. And, as with learning an instrument, say the researchers, "the more one practices the better one becomes".

Back in control

The researchers trialled their system on a female patient who has locked-in syndrome, a form of almost total paralysis caused by brain lesions, at the Royal Hospital for Neuro-disability in London. During a two-hour session, she got the hang of the system and was eventually playing along with a backing track. She reported that "it was great to be in control again".
Goebel points out that the patients still need to be able to control their eye movements, which people with total locked-in syndrome cannot. In such partial cases, he says, "one can usually use gaze directly for controlling devices, instead of an EEG system". But Miranda points out that eye-gazing alone does not permit variations in the intensity of the signal. "Eye gazing is comparable to a mouse or joystick," he says. "Our system adds another dimension, which is the intensity of the choice. That's crucial for our musical system."
Miranda says that although increasing the complexity of the musical tasks is not a priority, music therapists have suggested it would be better if the system were more like a musical instrument — for instance, with an interface that looks like a piano keyboard. He admits that it is not easy to raise the number of buttons or keys beyond four, but is confident that "we will get there eventually".
"The flashing thing does not need to be on a computer screen," he says. It could, for example, be a physical electronic keyboard with light-emitting diodes on the keys. "You could play it by staring at the keys," he says.

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Beautiful theory collides with smashing particle data

Latest results from the LHC are casting doubt on the theory of supersymmetry.
Geoff Brumfiel

“Any squarks in here?” The ATLAS detector (above) at the Large Hadron Collider has failed to find predicted ‘super partners’ of fundamental particles.C. MARCELLONI/CERN

"Wonderful, beautiful and unique" is how Gordon Kane describes supersymmetry theory. Kane, a theoretical physicist at the University of Michigan in Ann Arbor, has spent about 30 years working on supersymmetry, a theory that he and many others believe solves a host of problems with our understanding of the subatomic world.

Yet there is growing anxiety that the theory, however elegant it might be, is wrong. Data from the Large Hadron Collider (LHC), a 27-kilometre proton smasher that straddles the French–Swiss border near Geneva, Switzerland, have shown no sign of the 'super particles' that the theory predicts[1–3]. "We're painting supersymmetry into a corner," says Chris Lester, a particle physicist at the University of Cambridge, UK, who works with the LHC's ATLAS detector. Along with the LHC's Compact Muon Solenoid experiment, ATLAS has spent the past year hunting for super particles, and is now set to gather more data when the LHC begins a high-power run in the next few weeks. If the detectors fail to find any super particles by the end of the year, the theory could be in serious trouble.

Supersymmetry (known as SUSY and pronounced 'Susie') emerged in the 1970s as a way to solve a major shortcoming of the standard model of particle physics, which describes the behaviour of the fundamental particles that make up normal matter (see 'The bestiary'). Researchers have now found every particle predicted by the model, save one: the Higgs boson, theorized to help endow other particles with mass.

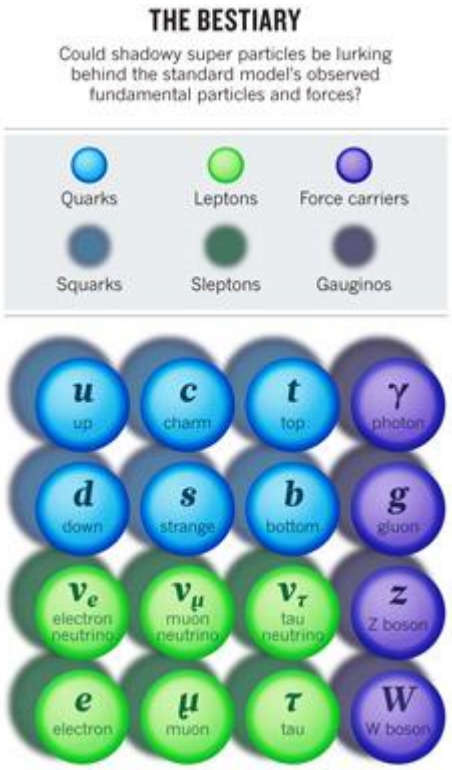
The Higgs is crucial to the theory, but its predicted mass is subject to wild fluctuations caused by quantum effects from other fundamental particles. Those fluctuations can increase the Higgs' expected mass to a point at which other fundamental particles should be much more massive than they actually are, effectively breaking the standard model. Theorists can eliminate the fluctuations from their equations, but only by setting the Higgs mass to a very precise value — a fraction heavier or lighter and the whole theoretical edifice collapses. Many physicists are uncomfortable with any theory that requires such delicate fine-tuning to work.

SUSY offers an alternative to this 'fine-tuning' problem. The theory postulates that each regular particle has a heavier supersymmetrical partner, many of which are unstable and rarely interact with normal matter. The quantum fluctuations of the supersymmetrical particles perfectly cancel out those of the regular particles, returning the Higgs boson to an acceptable mass range.

Theorists have also discovered that SUSY can solve other problems. Some of the lightest supersymmetrical particles could be the elusive dark matter that cosmologists have been hunting for since the 1930s. Although it has never been seen, dark matter makes up about 83% of the matter in the Universe, according to observations of how galaxies move. SUSY can also be used to bring together all the forces except gravity into a single force at high energies, a big step towards a 'theory of everything' that unifies and explains all known physics — one of the ultimate goals of science. Perhaps most important for some theorists, "SUSY is very beautiful mathematically", says Ben Allanach, a theorist at the University of Cambridge.

SUSY's utility and mathematical grace have instilled a "religious devotion" among its followers, says Adam Falkowski, a theorist at the University of Paris-South in France. But colliders have failed to turn up direct evidence of the super particles predicted by the theory. The Tevatron at the Fermi National Accelerator

Laboratory in Batavia, Illinois, for example, has found no evidence of supersymmetrical quarks ('squarks') at masses of up to 379 gigaelectronvolts (energy and mass are used interchangeably in the world of particle physics).



The LHC is now rapidly accumulating data at higher energies, ruling out heavier territory for the super particles. This creates a serious problem for SUSY (see 'SUSY's mid-life crisis'). As the super particles increase in mass, they no longer perfectly cancel out the troubling quantum fluctuations that they were meant to correct. Theorists can still make SUSY work, but only by assuming very specific masses for the super particles — the kind of fine-tuning exercise that the theory was invented to avoid. As the LHC collects more data, SUSY will require increasingly intrusive tweaks to the masses of the particles.

So far the LHC has doubled the mass limit set by the Tevatron, showing no evidence of squarks at energies up to about 700□gigaelectronvolts. By the end of the year, it will reach 1,000□gigaelectronvolts — potentially ruling out some of the most favoured variations of supersymmetry theory.

"I wouldn't say I'm concerned," says John Ellis, a theorist at CERN, Europe's particle-physics lab near Geneva, who has worked on supersymmetry for decades. He says that he will wait until the end of 2012 — once more runs at high energy have been completed — before abandoning SUSY. Falkowski, a long-time critic of the theory, thinks that the lack of detections already suggest that SUSY is dead.

"Privately, a lot of people think that the situation is not good for SUSY," says Alessandro Strumia, a theorist at the University of Pisa in Italy, who recently produced a paper about the impact of the LHC's latest results on the fine-tuning problem[4]. "This is a big political issue in our field," he adds. "For some great physicists, it is the difference between getting a Nobel prize and admitting they spent their lives on the wrong track." Ellis agrees: "I've been working on it for almost 30 years now, and I can imagine that some people might get a little bit nervous."

"Plenty of things will change if we fail to discover SUSY," says Lester. Theoretical physicists will have to go back to the drawing board and find an alternative way to solve the problems with the standard model. That's not necessarily a bad thing, he adds: "For particle physics as a whole it will be really exciting."

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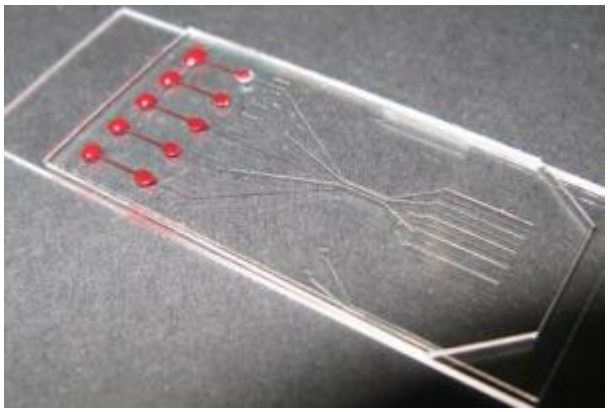
New Blood Analysis Chip Could Lead to Disease Diagnosis in Minutes



Photograph of the stand alone 1x2 inch SIMBAS chip simultaneously processing five separate whole-blood samples by separating the plasma from the blood cells and detecting the presence of biotin, or vitamin B7. (Credit: Ivan Dimov)

ScienceDaily (Mar. 18, 2011) — A major milestone in microfluidics could soon lead to stand-alone, self-powered chips that can diagnose diseases within minutes. The device, developed by an international team of researchers from the University of California, Berkeley, Dublin City University in Ireland and Universidad de Valparaíso Chile, is able to process whole blood samples without the use of external tubing and extra components.

The researchers have dubbed the device SIMBAS, which stands for Self-powered Integrated Microfluidic Blood Analysis System. SIMBAS appeared as the cover story March 7 in the peer-reviewed journal *Lab on a Chip*.

"The dream of a true lab-on-a-chip has been around for a while, but most systems developed thus far have not been truly autonomous," said Ivan Dimov, UC Berkeley post-doctoral researcher in bioengineering and co-lead author of the study. "By the time you add tubing and sample prep setup components required to make previous chips function, they lose their characteristic of being small, portable and cheap. In our device, there are no external connections or tubing required, so this can truly become a point-of-care system."

Dimov works in the lab of the study's principal investigator, Luke Lee, UC Berkeley professor of bioengineering and co-director of the Berkeley Sensor and Actuator Center.

"This is a very important development for global healthcare diagnostics," said Lee. "Field workers would be able to use this device to detect diseases such as HIV or tuberculosis in a matter of minutes. The fact that we reduced the complexity of the biochip and used plastic components makes it much easier to manufacture in high volume at low cost. Our goal is to address global health care needs with diagnostic devices that are functional, cheap and truly portable."

For the new SIMBAS biochip, the researchers took advantage of the laws of microscale physics to speed up processes that may take hours or days in a traditional lab. They note, for example, that the sediment in red wine that usually takes days to years to settle can occur in mere seconds on the microscale.

The SIMBAS biochip uses trenches patterned underneath microfluidic channels that are about the width of a human hair. When whole blood is dropped onto the chip's inlets, the relatively heavy red and white blood cells settle down into the trenches, separating from the clear blood plasma. The blood moves through the chip in a process called degas-driven flow.

For degas-driven flow, air molecules inside the porous polymeric device are removed by placing the device in a vacuum-sealed package. When the seal is broken, the device is brought to atmospheric conditions, and air molecules are reabsorbed into the device material. This generates a pressure difference, which drives the blood fluid flow in the chip.

In experiments, the researchers were able to capture more than 99 percent of the blood cells in the trenches and selectively separate plasma using this method.

"This prep work of separating the blood components for analysis is done with gravity, so samples are naturally absorbed and propelled into the chip without the need for external power," said Dimov.

The team demonstrated the proof-of-concept of SIMBAS by placing into the chip's inlet a 5-microliter sample of whole blood that contained biotin (vitamin B7) at a concentration of about 1 part per 40 billion.
"That can be roughly thought of as finding a fine grain of sand in a 1700-gallon sand pile," said Dimov.
The biodetectors in the SIMBAS chip provided a readout of the biotin levels in 10 minutes.
"Imagine if you had something as cheap and as easy to use as a pregnancy test, but that could quickly diagnose HIV and TB," said Benjamin Ross, a UC Berkeley graduate student in bioengineering and study co-author. "That would be a real game-changer. It could save millions of lives."
"The SIMBAS platform may create an effective molecular diagnostic biochip platform for cancer, cardiac disease, sepsis and other diseases in developed countries as well," said Lee.
Other co-lead authors of the study are Lourdes Basabe-Desmonts, senior scientist at Dublin City University's Biomedical Diagnostics Institute, and Jose L. Garcia-Cordero, currently post-doctoral scientist at École Polytechnique Fédérale de Lausanne (EPFL Switzerland). Antonio J. Ricco, adjunct professor at the Biomedical Diagnostics Institute at Dublin City University, also co-authored the study.
The work was funded by the Science Foundation Ireland and the U.S. National Institutes of Health.

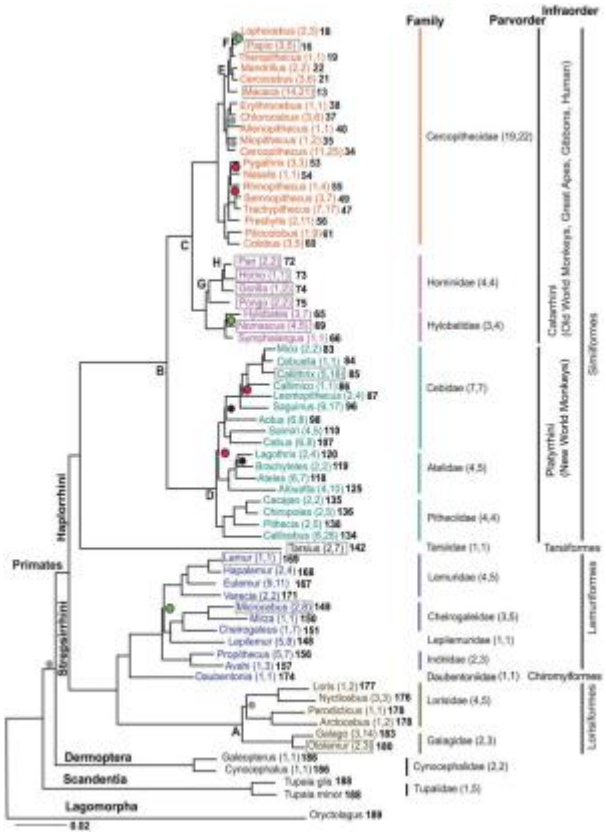
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of California - Berkeley**. The original article was written by Sarah Yang.

Journal Reference:

1. Ivan K. Dimov, Lourdes Basabe-Desmonts, Jose L. Garcia-Cordero, Benjamin M. Ross, Antonio J. Ricco, Luke P. Lee. **Stand-alone self-powered integrated microfluidic blood analysis system (SIMBAS)**. *Lab on a Chip*, 2011; 11 (5): 845 DOI: 10.1039/C0LC00403K

http://www.sciencedaily.com/releases/2011/03/110318102243.htm

A New Evolutionary History of Primates



The molecular phylogeny of 61 Primate genera, two Dermoptera genera, and one Scandentia genus and rooted by Lagomorpha. (Credit: Polina Perelman, Warren E. Johnson, Christian Roos, Hector N. Seuánez, Julie E. Horvath, Miguel A. M. Moreira, Bailey Kessing, Joan Pontius, Melody Roelke, Yves Rumpler, Maria Paula C. Schneider, Artur Silva, Stephen J. O'Brien, Jill Pecon-Slattery. A Molecular Phylogeny of Living Primates. PLoS Genetics, 2011; 7 (3): e1001342 DOI: 10.1371/journal.pgen.1001342)

ScienceDaily (Mar. 17, 2011) — A robust new phylogenetic tree resolves many long-standing issues in primate taxonomy. The genomes of living primates harbor remarkable differences in diversity and provide an intriguing context for interpreting human evolution. The phylogenetic analysis was conducted by international researchers to determine the origin, evolution, patterns of speciation, and unique features in genome divergence among primate lineages.

This evolutionary history will be published on March 17 in the open-access journal *PLoS Genetics*.

The authors sequenced 54 gene regions from 186 species spanning the primate radiation. The analysis illustrates the importance of resolving complex, species-rich phylogenies using large-scale comparative genomic approach. Patterns of species and gene sequence evolution and adaptation relate not only to human genome organization and genetic disease sensitivity, but also to global emergence of zoonoses (human pathogens originating from non-human disease reservoirs), to mammalian comparative genomics, to primate taxonomy and to species conservation.

To date, available molecular genetic data applied to primate systematics has been informative, but limited in scope and constrained to just specific subsets of taxa. Now, a team of international researches from the US, Brazil, France and Germany, have provided a highly robust depiction of the divergence hierarchy, mode and tempo governing the extraordinarily divergent primate lineages. The findings illustrate events in primate evolution from ancient to recent and clarify numerous taxonomic controversies. Ongoing speciation, reticulate evolution, ancient relic lineages, unequal rates of evolution and disparate distributions of genetic insertions/deletions among the reconstructed primate lineages are uncovered.

The authors said: "Advances in human biomedicine, including those focused on changes in genes triggered or disrupted in development, resistance/susceptibility to infectious disease, cancers, and mechanisms of recombination and genome plasticity, can not be adequately interpreted in the absence of a precise evolutionary context or hierarchy. Resolution of the primate species phylogeny here provides a validated framework essential in the development, interpretation and discovery of the genetic underpinnings of human adaptation and disease."

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

Journal Reference:

1. Polina Perelman, Warren E. Johnson, Christian Roos, Hector N. Seuánez, Julie E. Horvath, Miguel A. M. Moreira, Bailey Kessing, Joan Pontius, Melody Roelke, Yves Rumpler, Maria Paula C. Schneider, Artur Silva, Stephen J. O'Brien, Jill Pecon-Slattery. **A Molecular Phylogeny of Living Primates**. *PLoS Genetics*, 2011; 7 (3): e1001342 DOI: 10.1371/journal.pgen.1001342

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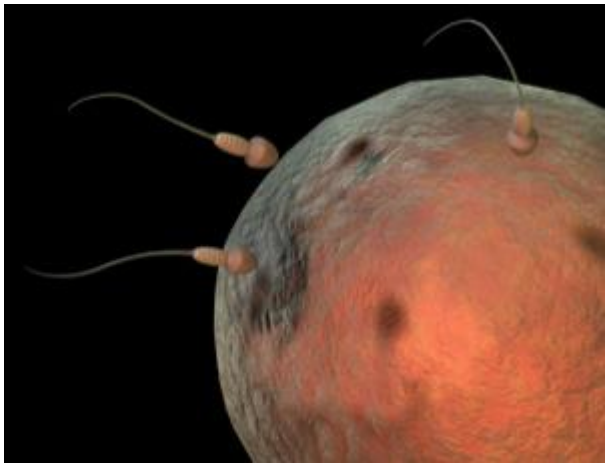
How human eggs woo sperm

- 18 March 2011 by **Ferris Jabr**
- Magazine issue 2804.



Come and get me (Image: Fotex/Rex Features)

WHEN a human egg is ready to be fertilised, it releases a chemical that signals "come hither" to nearby sperm. Now we know how this signal whips sperm into shape, which might make it possible to develop non-hormonal contraceptives that turn the signal off.

Although biologists have known for decades that egg cells provide sperm with a little chemical encouragement to reel them in, the molecular nature of this interaction has remained elusive.

To investigate, Polina Lishko at the University of California, San Francisco, and colleagues refined a technique to measure the electrical currents that drive the sinuous movements of a sperm's tail. Lishko's team found that when the sperm get a boost of progesterone - a hormone released by follicular cells surrounding the egg - the electric current increases in strength and their tails move faster.

It also turns out that progesterone binds to an ion channel on the sperm cell called CatSper, and that this causes an influx of calcium ions to propel the sperm forward (*Nature*, DOI: 10.1038/nature09767).

"This is one of the first times that people have figured out at the molecular level how an egg signals to a sperm," says Dejian Ren, a physiologist at the University of Pennsylvania in Philadelphia.

The discovery offers an opportunity to create non-hormonal birth control in the form of a drug that prevents progesterone from binding to CatSper, effectively preventing the egg wooing the sperm. Current hormonal contraceptives may increase the risk of certain cancers and cardiovascular disease.

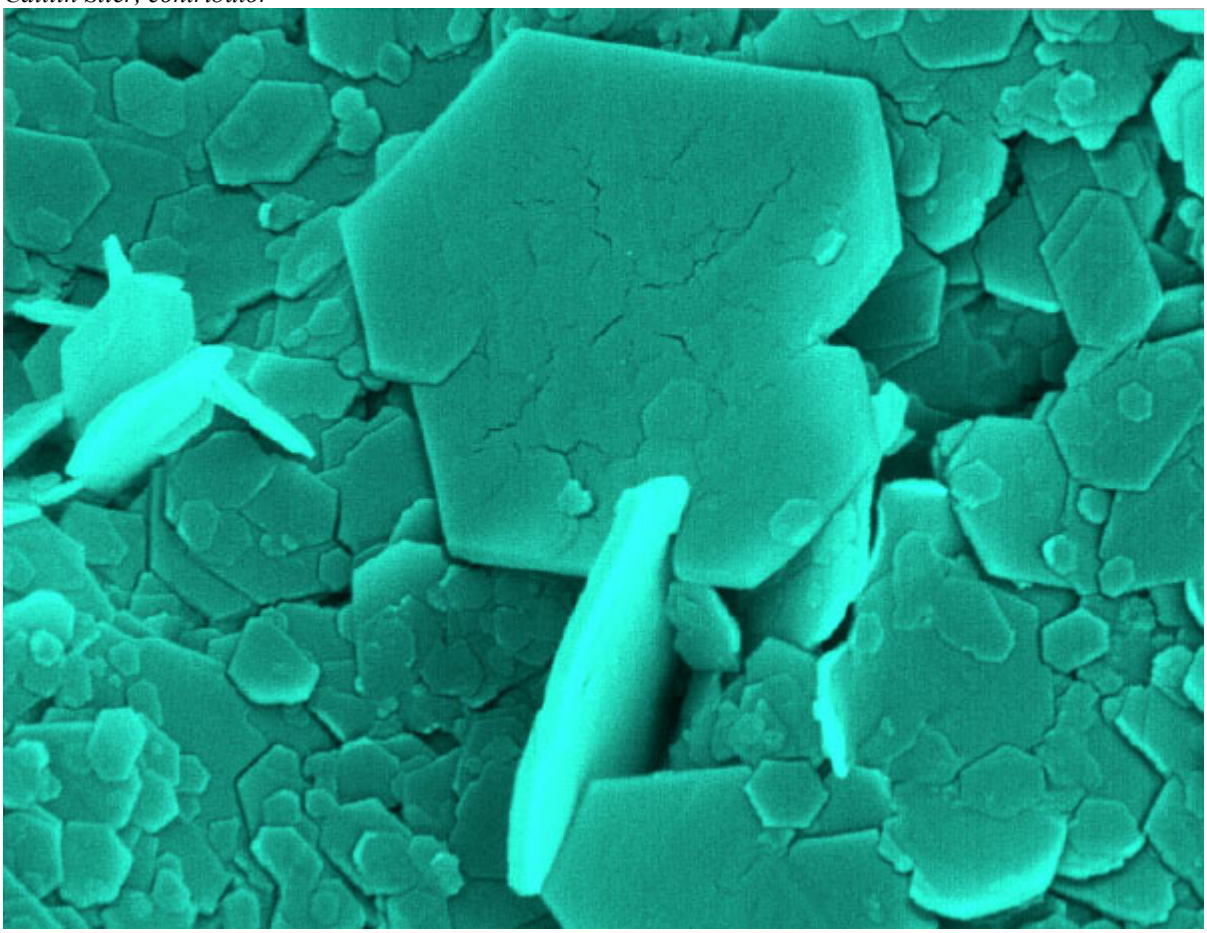
"We've finally solved the question of what progesterone does to human sperm," Lishko says. "Now we need to find the exact binding site on CatSper to move forward with drug therapy."

http://www.newscientist.com/article/mg20928043.400-how-human-eggs-woo-sperm.html?full=true&print=true

'Green rust' counteracts radioactive waste

22:41 18 March 2011

Caitlin Stier, contributor



(Image: Bo C. Christiansen/University of Copenhagen)

A highly reactive form of rust could be used to contain radioactive neptunium waste from nuclear power plants.

Green rust (pictured above) is a type of clay consisting of iron that has not entirely rusted. It has a deficit of electrons, making it react easily with other substances, including common pollutants.

Now, Bo Christiansen of the University of Copenhagen in Denmark and colleagues say it can help contain radioactive neptunium, a byproduct of uranium reactors with a half-life of more than 2 million years. The waste is disposed of in iron-lined copper vessels that are submerged in water.

Christiansen and colleagues say that surrounding these vessels with green rust could help ensure the waste does not seep into waterways should the containers break down.

Journal reference: *Geochimica et Cosmochimica Acta*, DOI: 10.1016/j.gca.2010.12.003

http://www.newscientist.com/blogs/shortsharpscience/2011/03/green-rust-counteracts-radioac.html

Dark energy is not an illusion after all

- 15:54 16 March 2011 by **David Shiga**

New measurements of exploding stars are challenging an upstart theory that dark energy is just an illusion caused by our location within a giant void.

In 1998, astronomers reported that the universe's expansion seems to be faster now than it was in the past, based on measurements of supernova explosions in both nearby and distant galaxies. The latter provide a record of the past because of the time it takes their light to reach us.

That the universe's expansion could be accelerating was a surprise, since gravity should act as a brake on the expansion, slowing it with time. The most popular explanation is that energy of unknown origin – called dark energy – permeates space and acts as a repulsive force to speed up the expansion.

But some researchers have proposed an alternative: that the acceleration is an illusion that results from an uneven distribution of matter in the universe.

Dark pedal

They accept that the expansion rate in the local universe is higher than in more distant regions. But instead of assuming the expansion rate has increased with time, they suggest our patch of the universe happens to contain less matter than average. Within this "void", the expansion rate is higher than outside because there is less gravity to slow it down.

But new, more precise measurements of supernovae, taken by the Hubble Space Telescope, clash with the simplest version of the void model. That model could be made to fit previous supernova measurements and other cosmological data, but only if the local expansion rate is about 60 kilometres per second per megaparsec or less. (One megaparsec is 3.26 million light years.)

That was within the possible error of previous measurements, but the new, more precise measurements give an expansion rate of 74 kilometres per second per megaparsec, plus or minus 2.4.

"It looks more like it's dark energy that's pressing the gas pedal," says Adam Riess of Johns Hopkins University in Baltimore, Maryland, who led the observations. The results appear in *The Astrophysical Journal*.

Void within a void?

But Subir Sarkar of the University of Oxford, a proponent of the void theory who was not involved in Riess's study, says the results are not a fatal blow. "The observers have done a good job, but it should be kept in mind that there is some flexibility in the alternative models, which can in fact accommodate higher values" for the local expansion, he says.

He points to a study by Tirthabir Biswas of Saint Cloud State University in Minnesota and colleagues, published in November in the *Journal of Cosmology and Astroparticle Physics*, which tested a variety of void models against astronomical data. Some of them allow local expansion rates as high as the new Hubble value by positing a "void within a void", where the density of matter is not constant within the void itself, but drops off steeply towards its centre.

Although such a model might seem contrived, the alternative is to invoke dark energy, whose origin is very hard to explain, says Sarkar. "I would rather believe that the universe is a little more complicated than the standard cosmological model assumes it to be," he says.

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The darkest thing in the universe

- 10 March 2011 by **Stephen Battersby**
- Magazine issue 2802.

Not much to see here (Image: Sloan Digital Sky Survey)

Galaxies are supposed to be glittering jewels, studded with billions of bright stars and glowing nebulae. Not so Segue 1, the dark horse of the galactic neighbourhood. Segue 1 is only 75,000 light years away, making it a near neighbour of the Milky Way, yet it remained undiscovered until 2006 because its total light emission is only 300 times that of our sun.

That is odd. Segue 1's few stars are moving around quite fast, so its gravity must be reasonably strong, implying that it contains at least a million solar masses of matter. Very little of that can be accounted for by visible stars and gas, suggesting that almost all of it must be exotic dark matter.

Studying dwarf galaxies like Segue 1 could tell us more about dark matter. For example, if the cores of these galaxies are less dense than predicted by the standard assumptions of how cold dark matter should behave, it could mean that the stuff is warm, or prone to self-destruct, or made from ultra-light particles that are inherently fuzzy.

Even better would be finding a "dark star" - a cool, fat blob of gas gently warmed from within by decaying dark matter. Such beasts are thought to have existed in the very early universe, and there may still be a few around today, but none has yet been spotted.

Meanwhile CERN's Large Hadron Collider is being used to hunt for possible dark-matter particles, so perhaps the hottest thing on Earth will soon illuminate the dimmest thing in space.

Read more: "Extreme universe: Eight cosmic record-breakers"

Stephen Battersby *is a freelance writer based in London*

http://www.newscientist.com/article/mg20928026.800-eight-extremes-the-darkest-thing-in-the-universe.html?full=true&print=true

Rubbery muscle motors to make robots more lifelike

- 17 March 2011 by **Duncan Graham-Rowe**
- Magazine issue 2803.

The future is soft (Image: Yoshikazu Tsuno/AFP/Getty)

IT WOBBLES like a jelly, but could make robots more flexible than ever before. Soft artificial muscles have been used to make a motor with only a few parts, and no gears, bearings or cogs.

The motor signals a new dawn for artificial muscles, says Iain Anderson, head of the Auckland Bioengineering Institute's Biomimetics Lab in New Zealand, where it was created.

The muscles themselves are electroactive structures consisting of two layers of conducting carbon grease separated by an extremely stretchy insulating polymer film, says Anderson. "It can stretch by more than 300 per cent."

When a voltage is applied, the configuration behaves like a capacitor, with positive and negative charges accumulating on either side of the insulator. As the opposite charges attract one another the insulator is squashed between them and flattens and stretches. Turn the voltage off and it contracts again to its original size.

The motor looks rather like a bicycle wheel, with the elastic muscles stretched between the edge of the wheel and the centre, like flat spokes. To turn a shaft, six of the muscles work in concert, contracting one after the other. Although the device looks as if it is wobbling like jelly, the spokes are connected to a foam ring wrapped tightly around the central shaft, and this arrangement exerts a continuous rotational force.

This is not the first time electroactive polymers (EAPs) have been used to create rotary motion, says Anderson. But previous efforts used a sort of ratcheting mechanism instead of the foam ring. Anderson's design removes the need for bearings, gears or anything else that is rigid.

"There's huge potential for this kind of actuator," says Chris Melhuish, director of the Bristol Robotics Lab in the UK. "We are going to have a different class of robot." Robots made of artificial muscle would feel soft and flesh-like and would be able to mimic the dexterity and mobility of living creatures, without the need for rigid mechanical components.

These kinds of EAPs are extremely strong, says Yosef Bar-Cohen, who specialises in electroactive materials at NASA's Jet Propulsion Laboratory in Pasadena, California - many times stronger than their biological counterparts. The simplified motor that Anderson has built opens up a whole new range of uses for artificial muscles, he says.

For example, they could be used to make instruments for keyhole surgery that are soft enough to be squeezed through tiny incisions but still able to perform the jobs of more rigid mechanical devices.

A company called Artificial Muscle in Sunnyvale, California, is developing EAP-based motors designed to behave like haptic displays, which respond when they are touched. They provide tactile feedback for cellphones, computer mice and touchscreens, producing a range of different feelings beneath a user's

fingertips. They can produce the satisfying "click" sensation of a real button when typing on a touchscreen, for example.
The first of these, designed for the iPhone, will become available in May. It will replace the traditional vibrate function, and its diaphragm-like design allows it to respond much faster than the motors currently used in cellphones and produce a broader range of frequencies, says Andy Chen of Artificial Muscle.
Anderson's design will be presented at the Electroactive Polymer Actuators and Devices conference in San Diego, California, this week, along with the iPhone device. Also on display will be EAPs capable of generating electricity by a reverse process, creating a current when physically pumped, as well as robots that can harvest their own power and muscles that provide sensory feedback.
"I'd like to think that the future is soft," says Anderson.

http://www.newscientist.com/article/mg20928035.300-rubbery-muscle-motors-to-make-robots-more-lifelike.html?full=true&print=true

Obesity expert: A better fat measure than BMI

- 17 March 2011 by **Alison George**
- Magazine issue 2803.

New ways of indexing obesity (Image: Rob Greer)

For nearly 200 years, the body mass index has been used as a measure of obesity. ***Richard Bergman*** *argues it could be time for a change*

You have come up with an alternative to the body mass index as a measure of obesity. First off, what's wrong with BMI?

The BMI has been around since the 1840s, but it has a number of weaknesses. Firstly, it doesn't give a real estimate of percentage body fat. Secondly, the BMI can be quite different for a man and a woman with the same percentage of body fat. And thirdly, your BMI can be high even if you don't have much fat, especially if you are male and very muscular.

How did you go about searching for an alternative to BMI?

Our goal was to find a simple index of obesity, something that a practising clinician could use. To do that we looked at a population of 2000 people of Latin American descent who had had their percentage body fat measured directly using dual-energy X-ray absorption, which is an accurate way to quantify body fat. We then asked what parameters we could measure in these people that would best predict the true percentage of fat.

What did you find?

It turned out that hip circumference and height were more correlated with percentage body fat than anything else, including waist circumference and weight. So we designed an equation that could take both of these into account. We call this the Body Adiposity Index. It turns out that BAI is a good predictor of percentage adiposity, so if your BAI is 30, then your percentage body fat is around 30 per cent. It is reasonably accurate - not terribly accurate - but usable as a clinical tool.

Is BAI better than BMI?

We think it's better, but we have still got to prove it. Unlike BMI, the BAI for men and women is the same if they have the same percentage body fat. We have validated the BAI in African American populations too. Its utility has not been confirmed in Caucasian subjects, although we have tested it on a small group and it seemed to fit.

What are the downsides of the BAI?

The real challenge is to be able to predict the risk of obesity-related diseases such as cancer, diabetes, cardiovascular disease and hypertension, and then to intervene. It remains to be shown that BAI is a more useful predictor of these outcomes than other measures of body adiposity.

Were you surprised that weight isn't part of the BAI calculation?

Yes. But this means that BAI has the unexpected characteristic that it can be used where scales are unavailable or not correctly calibrated. BAI could be useful in remote locations with no reliable scales; in India, for example, where obesity is a serious problem.

Do you think BAI will one day succeed BMI as a measure of obesity?

I am agnostic on that, but I'm hopeful that BAI is better than BMI, which is misused by a lot of medical practitioners who don't realise that it is often not a good measure of percentage body fat.

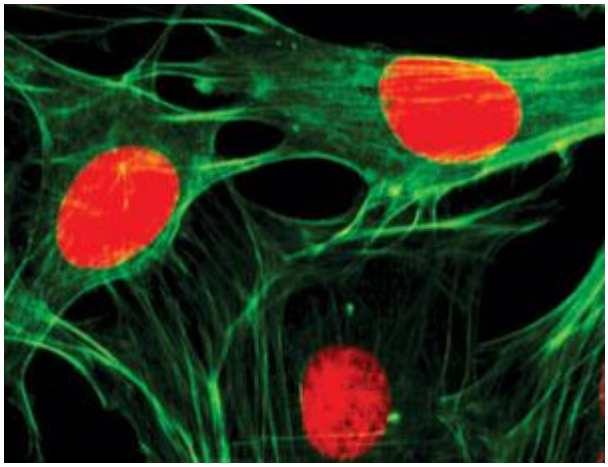
Profile

Richard Bergman is a professor of medicine at the University of Southern California in Los Angeles. His research focuses on obesity and type 2 diabetes

http://www.newscientist.com/article/mg20928030.200-obesity-expert-a-better-fat-measure-than-bmi.html?full=true&print=true

Tumours could be the ancestors of animals

- 11 March 2011 by **Colin Barras**
- Magazine issue 2803.



Your distant ancestor? (Image: David Becker/Getty)

CANCER remains a formidable foe even 40 years after Richard Nixon officially declared war on it. A new and controversial hypothesis now offers hope that the war can ultimately be won. It suggests tumours have a limited ability to evade modern therapies - a consequence of the idea that cancer is our most distant animal ancestor, a "living fossil" from over 600 million years ago.

Some cancers evolve resistance to a treatment within a few years. One possible explanation for this is that the cells within a tumour act independently, competing with one another via natural selection to evolve therapy-dodging innovations.

Astrobiologists Charles Lineweaver at the Australian National University in Canberra and Paul Davies at Arizona State University in Tempe have an alternative explanation. They say that evidence of basic cellular cooperation within tumours suggests cancers are a throwback from the origin of the animal kingdom - and that any ability to resist modern drugs relies on an ancient and ultimately limited array of survival tactics.

Their hypothesis builds on an old idea that suggests a link between cancer and the origin of multicellular animals, sometime before 600 million years ago. For billions of years before that point, the animals' single-celled ancestors replicated with reckless abandon. Once organisms contained multiple cells, however, replication had to become more restrained, to avoid adverse effects on the organism.

Cancer is thought to be triggered by a malfunction of the genes that try to hold back this uncontrolled replication. But Lineweaver and Davies go further: cancer is not simply linked to the evolution of animals - it was the earliest animals. They believe these organisms had cracked the problem of runaway replication but they still lacked total control over cell growth and proliferation.

The hypothesis helps to explain some of the more unusual features of tumours, says Lineweaver. Some cancer cells build a network of blood vessels, a process known as angiogenesis, to bring nutrients into the tumour - evidence of tumour-wide cooperation. Other cells gain the ability to spread to other tissues, or metastasise, which is difficult to explain if all cancer cells act independently.

Lineweaver and Davies think the genetic toolkit at work in these first animals is buried within all of us. The genes that came later might have tinkered with it, but whenever those later additions malfunction the ancient genes can revert to their initial function.

Consequently, a tumour is not a collection of independently evolving cells, like bacteria, with almost infinite potential to evolve resistance to therapy. It is a group of largely cooperating cells relying on a finite collection of survival strategies that were locked in place over half a billion years ago (*Physical Biology*, DOI: 10.1088/1478-3975/8/1/015001).

Reactions to Lineweaver and Davies's idea vary from cautious enthusiasm to outright scepticism. Carlo Maley at the University of California in San Francisco, who studies the evolutionary processes at work in cancer, is receptive: "They make a bunch of interesting predictions," he says.
Others are more guarded. It is an "imaginative metaphor", says Mansi Srivastava at the Whitehead Institute for Biomedical Research in Cambridge, Massachusetts, who studies the evolution of genes including those involved with cancer. However, she thinks the idea of cancer as a living fossil from the dawn of animal life is a step too far. "There is no evidence to believe that the ability to develop blood vessels is an ancient feature of animals."
Lineweaver disagrees: "Fully developed angiogenesis had to have evolved from proto-angiogenesis," he says. "I think it's clear that some form of proto-angiogenesis was very important for the earliest animals."
Genetic profiling may soon help to test the hypothesis, says Lineweaver. The ways a particular cancer responds to treatment in different people should correlate with each other, he says, because they should share strategies for dealing with toxins that were developed in the earliest animals.
Even if cancer does have a limited ability to resist treatment, though, Maley has a reality check. If the war on cancer has taught us anything, it is that battling even a predictable cancer will remain "plenty hard" in the short term.

http://www.newscientist.com/article/mg20928033.700-tumours-could-be-the-ancestors-of-animals.html

The curious incident of the koala in the night-time

14:35 7 March 2011
Life
Matt Kaplan, contributor

Evening activity (Image: Sunset/Rex Features)

It might come as a surprise to find that anything remains to be learned about an animal as charismatic as the koala. But there are a great many questions surrounding the marsupials' nocturnal behaviour that have remained unanswered for decades. Chief among them is why the tree hugging beasts bellow around the midnight hour.

Some have speculated that, like the calls of bison and many primates, these bellows might warn rival males to get out of the bellower's territory. Others have suggested that the deep bellows have a Barry White-like ability to attract females. But in truth biologists are largely in the dark over the issue because the calls occur, well, in the dark.

Now some light has been shed on the matter. A tracking study seems to have confirmed that male Koalas bellow to impress nearby females.

Bill Ellis at the San Diego Zoo Institute for Conservation Research in California and Fred Bercovitch at Kyoto University, Japan, caught twelve koalas - six males and six females - on St Bees Island in Australia, before attaching GPS and radio collars to them. The team also planted three listening stations in the koalas' habitat. Between all of this technology, the team could calculate when and where a bellow was made, and how nearby koalas reacted.

Ellis and Bercovitch figured that if the bellows were being used by males to warn off the competition, silent males would move away from a bellower. Yet even the deepest grunts failed to encourage males to budge an

inch. Instead, it was the females that did the moving - towards the source of the bellow (*Behavioral Ecology*, DOI: 10.1093/beheco/arq216).

So koala bellows are mating calls after all. And the reason males call around midnight? Ellis and Bercovitch reckon koala females are more likely to be asleep during the day, curled up in shady trees to protect them from the heat: there's little point in bellowing if nobody's listening.

http://www.newscientist.com/blogs/shortsharpscience/2011/03/the-curious-incident-of-the-ko.html

Biology's 'dark matter' hints at fourth domain of life

- 21:00 18 March 2011 by **Colin Barras**

Step far enough back from the tree of life and it begins to look quite simple. At its heart are just three stout branches, representing the three domains of life: bacteria, archaea and eukaryotes. But that's too simple, according to a band of biologists who believe we may be on the verge of discovering the fourth domain of life.

The bold statement is the result of an analysis of water samples collected from the world's seas. Jonathan Eisen at the University of California, Davis, Genome Center has identified gene sequences hidden within these samples that are so unusual they seem to have come from organisms that are only distantly related to cellular life as we know it. So distantly related, in fact, that they may belong to an organism that sits in an entirely new domain.

Most species on the planet look like tiny single cells, and to work out where they fit on the tree of life biologists need to be able to grow them in the lab. Colonies like this give them enough DNA to run their genetic analyses. The problem is, the vast majority of these cells species – 99 per cent of them is a reasonable bet – refuse to be cultured in this way. "They really are the dark matter of the biological universe," says Eisen.

Life's dark matter

To probe life's dark matter, Eisen, Craig Venter of the J. Craig Venter Institute in Rockville, Maryland, and their colleagues have resorted to a relatively new technique called metagenomics. This can "sequence the crap out of any DNA samples", whether they are collected from the environment or come from lab cultures, says Eisen.

When Eisen and Venter used the technique on samples collected from the Global Ocean Sampling Expedition, they found that some sequences belonging to two superfamilies of genes – *recA* and *rpoB* – were unlike any seen before.

"The question is, what are they from?" says Eisen. Because the team has no idea what organism the genes belong to, the question remains unanswered. There are two possibilities, he says. "They could represent an unusual virus, which is interesting enough. More interestingly still, they could represent a totally new branch in the tree of life."

The exciting but controversial idea has met with mixed reactions. "It's a very good piece of careful work," says Eugene Koonin at the National Center for Biotechnology Information in Bethesda, Maryland.

Younger than they look?

But some think any talk of a fourth domain of cellular life is premature. Radhey Gupta at McMaster University in Hamilton, Ontario, Canada, calls the finding "very exciting", but cautions that there are other explanations.

For instance, the sequences could be from cellular organisms living in unique habitats that caused their genes to undergo rapid evolution. That would give the false impression that the "new" life forms diverged from all others a very long time ago.

"There is still debate [over] how to clearly distinguish the three proposed domains of life, and how they are interrelated," Gupta says. "The suggestion [of] a fourth domain will only add to the confusion."

Eric Bapteste at Pierre and Marie Curie University in Paris, France, is far more receptive. "The facts are that there is lots of genetic diversity, and unquestionably most of it is unknown to us," he says. "It's legitimate to consider that there's genuinely new stuff out there."

Further analysis of the samples could determine whether the two gene families studied have evolved unusually rapidly or are from a cellular organism with a universally bizarre genome, he says.

Parent organism

Looking at the actual samples could also help pin down exactly which organism the strange genetic sequences belong to, says Eisen.

If Eisen's gene sequences did turn out to belong to a new domain of life, it wouldn't be the first time the tree of life has had to be redrawn. Until the 1990s, it had just two branches: one for eukaryotes – animals, plants, fungi and some other strange forms, including the slime moulds – and one for everything else. Then, gene analysis revealed that the "everything else" branch could be divided into two domains: bacteria and archaea.

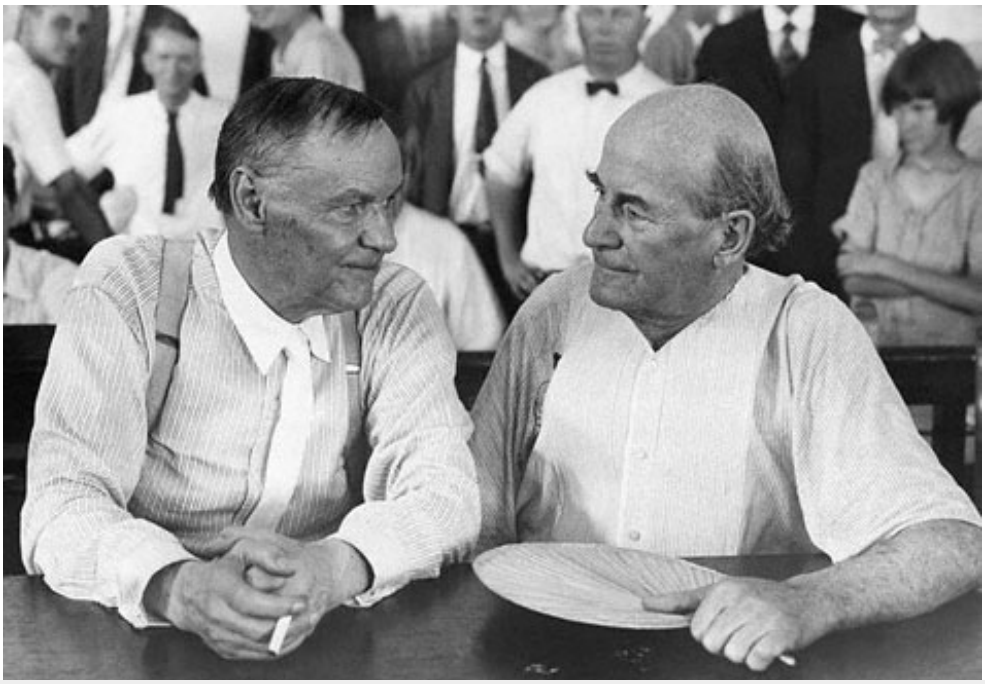
Not only that, some believe that mimivirus, the largest known virus, may also represent a new domain of life: despite being recognised as a virus, it contains many genes found only in cellular organisms. "People have suggested they might be a fourth branch themselves," says Eisen. "If you think of those mimiviruses as a fourth branch, maybe our sequences represent a fifth branch – we just don't know yet."
Journal reference: *PLoS One*, DOI: 10.1371/journal.pone.0018011

http://www.newscientist.com/article/dn20265-biologys-dark-matter-hints-at-fourth-domain-of-life.html

An Anti-Science Mania Takes Over GOP

Being vocally anti-science has become a defining mark of a current style of politics, an intentional ignorance that recalls the Scopes Monkey Trial, argues law professor Robert Benson.

By Robert Benson



Clarence Darrow, left, and William Jennings Bryan, defense lawyer and prosecutor, respectively, pictured during the Scopes Monkey Trial, circa 1925. Some would argue that there is a current anti-science sentiment that hearkens back to that time in history. (Wikipedia.org)

You've got to go back to the Scopes Monkey Trial of 1925 for a precedent to the anti-science mania that is currently sweeping the GOP. Then, the issue was teaching Darwin's work on evolution in the schools. Today, the issue is global warming. Then, as now, large numbers of politicians tapped into the stratum of popular culture that simply rejects science as the basis for public or personal decisions. The chief prosecutor of high school teacher John Scopes, William Jennings Bryan, gloated that literal interpretation of the Bible trumped scientific knowledge. This resonated with large masses of ordinary folks, the ones H. L. Mencken and the liberal press were calling "yokels" and "morons."

Turns out the yokels and morons won, at least for a generation. Scopes was found guilty of violating the Tennessee law that prohibited teaching evolution, and his conviction (though later overturned on a technicality) galvanized the anti-evolution movement for years. Politicians came pouring in. Scores of resolutions were introduced in state legislatures and school boards all over the country, setting back the teaching of evolution for decades until logic and reason and the scientific method gradually reasserted themselves in the culture.

Today, Republicans are falling over themselves in a rush to ridicule the science that shows our use of fossil fuels is producing greenhouse gases that are warming the planet to disastrous levels. These findings were confirmed even by the Bush administration before it left office, as well as by the U.S. National Academy of

Sciences and every other significant scientific academy around the world, not to mention the unpaid global work of hundreds of volunteer scientists for the Intergovernmental Panel on Climate Change.

But anti-scientists are undaunted by facts. More than half of the incoming Republican caucus denies the validity of climate change science. Some 74 percent of Republicans in the U.S. Senate now take that stance, as do 53 percent of GOP in the House. Here's a sampler of what some of their leading illuminati have to say about it:

"I personally believe that the solar flares are more responsible for climatic cycles than anything that human beings do. ..." — Rep. Jim Sensenbrenner, Wisconsin

"Nobody really knows the cause. The earth cools, the earth warms ... It could be caused by carbon dioxide or methane. Maybe we should kill the cows to stop the methane, or stop breathing to stop the CO2 ... Thousands of people die every year of cold, so if we had global warming it would save lives ... We ought to look out for people. The earth can take care of itself." — Rep. Duncan Hunter, California

"There was a report a couple of weeks ago that in fact you look at this last year, it was the warmest year in the last decade, I think was the numbers that came out. I don't — I accept that. I do not say that it is man-made." — Rep. Fred Upton, Michigan

"The greatest hoax ever perpetuated on the American people." — Sen. James Inhofe, Oklahoma

Rep. John Shimkus of Illinois says we need not worry about the planet being destroyed because, citing chapter 8, verse 22 of the Book of Genesis, God promised Noah it wouldn't happen again after the great flood.

Sen. John McCain co-authored a good global warming bill when running for president in 2008. But he did a 180-degree turnabout when running for re-election to Arizona's Senate seat two years later, suddenly saying, "There's great questions about it that need to be resolved."

What happened?

The Tea Party and its allies had made it unacceptable to the GOP base to be anywhere except pandering to the anti-science crowd.

None of this would have surprised historian Richard Hofstadter, who won a Pulitzer in 1964 for his book *Anti-Intellectualism in American Life*. Starting with the colonies, Hofstadter shows how the vast underlying stratum of anti-elite, anti-reason, anti-science Americans has frequently erupted into political and cultural action. These are folks who never heard of the Enlightenment of the 18th century, and do not experience a lot of reason, logic or the empirical method in their daily lives. They live by "common sense," personal relationships and superstition. They have always been with us, and there are a lot of them.

Their outburst into today's anti-science global warming mania would just be the latest chapter in Hofstadter's book.

You might think that the revolution of Internet-blogging-networking technology would work to spread sound scientific knowledge more broadly, but you would be wrong. The new technology spreads a cacophony of voices in which the pre-Enlightenment folks are not only equal but more numerous and dominant than the voices of reason.

Journalist Charles Pierce not long ago wrote an essay on "Idiot America," followed by a book of that name, in which he argued that "the rise of Idiot America today represents — for profit mainly, but also, and more cynically, for political advantage and in the pursuit of power — the breakdown of a consensus that the pursuit of knowledge is a good. It also represents the ascendancy of the notion that the people whom we should trust the least are the people who best know what they're talking about. In the new media age, everybody is a historian, or a preacher, or a scientist, or a sage. And if everyone is an expert, then nobody is, and the worst thing you can be in a society where everybody is an expert is, well, an actual expert."

Moreover, the new technology is not working alone. You have the likes of oil interests such as Koch Industries and Exxon Mobil funding a phalanx of anti-science spokesmen, think tanks and lobbyists. They put their money into sowing doubt about the scientific consensus, as many of these same people did on tobacco, ozone and acid rain, playing on the fact that the way science works is to set up repeated challenges of the evidence by peers but ignoring that scientific consensuses do indeed exist — otherwise, we would not have made the progress we did on tobacco, ozone and acid rain.

Sheltered by the technological cacophony and the big money available, politicians feel unashamed to stand in front of the National Academy of Sciences and virtually every climate scientist in the world and utter irrational things like "God promised Noah …," or "solar flares," or "nobody really knows," "not man-made" or "hoax."

"[The deniers'] goal is to create the perception that fundamental aspects of climate science are controversial," write several scientists connected to the National Academy. "They are not."

"All their claims, all the studies cited and all the evidence they have presented has been thoroughly reviewed by climate scientists. There is no scientific basis for contesting the academy's finding."

We are in Tennessee again, 1925, in the grip of the anti-scientists and their politicians. We will lose a generation in dealing with greenhouse gases. Yet the science says we have only a few years.

http://www.miller-mccune.com/environment/an-anti-science-mania-takes-over-gop-29255/?utm_source=Newsletter153&utm_medium=email&utm_content=0322&utm_campaign=newsletters

Study Links Facebook Use with Narcissism

New research from Australia suggests Facebook users are more extroverted and narcissistic than Internet users not plugged into the social network.

By Tom Jacobs

Maybe it is all about you. New research suggests Facebook users may demonstrate narcissistic and extroverted personalities compared with those who are not plugged into the social network. (istockphoto.com)

Who uses Facebook? The simple answer is a whole lot of people: The online social network has more than 600 million members.

But what sets them apart from those who use the Internet but have chosen not to play in Mark Zuckerberg's virtual playground? New research from Australia provides some less than flattering answers.

"Facebook users tend to be more extroverted and narcissistic, but less conscientious and socially lonely, than non-users," Tracii Ryan and Sophia Xenos of RMIT University in Melbourne write in the journal *Computers in Human Behavior.*

Instead of falling in love with his own image in a pond, today's narcissist apparently gazes adoringly at his own Facebook profile.

Seeing a gap in the literature (most previous surveys of Facebook users have been limited to university students), Ryan and Xenos decided to survey a wider range of Internet users in Australia (where, they report, nearly half the population consists of active Facebook users). Their sample consisted of 1,324 participants, all between the ages of 18 and 44. All but 166 of them were Facebook users.

The participants completed a 124-question online survey, which measured such things as their "big five" personality traits (extr0version, agreeableness, conscientiousness, neuroticism and openness to experience), narcissistic tendencies, shyness, loneliness, and the specifics of their Facebook usage.

Among Facebook users, the amount of time spent on the site per day varied widely. Seventeen percent of users reported they spent 10 minutes or less, 24 percent between 10 and 30 minutes, 23 percent between 31 and 60 minutes, 17 percent between one and two hours, and 19 percent two hours or more.

"There was a significant positive correlation between time spent on Facebook per day and two of the personality variables: neuroticism and total loneliness," the researchers report.

"The most preferred Facebook features were photos, messages, the wall and status updates. Games, notes and events were least preferred. Both the wall and messages appear to be the preferred means of communication on Facebook."

Ryan and Xenos report Facebook appeals to a wide variety of people, and it "gratifies its users in different ways depending on their individual characteristics." That said, their descriptions of the personality types that gravitate to the site are a bit disturbing.

"Firstly, Facebook users have higher levels of total narcissism, exhibitionism and leadership than Facebook non-users," they write. "Secondly, individuals with higher scores on exhibitionism also have higher preferences for photos and status updates (than the site's other features)."

These findings "substantiate the proposition that Facebook is particularly appealing for narcissistic and exhibitionistic people," they conclude. "In fact, it could be argued that Facebook specifically gratifies the narcissistic individual's need to engage in self-promoting and superficial behavior."

"One of the most noteworthy findings was the tendency for neurotic and lonely individuals to spend greater amounts of time on Facebook per day than non-lonely individuals," they add. "For lonely people in particular, it appears they are mainly using Facebook to partake in passive activities, instead of providing active social contributions."

It's worth repeating that these findings are exclusively from Australia, and thus not necessarily representative of Facebook's worldwide membership. And the number of nonusers in the study was relatively small. So this study cannot be called definitive.

Nevertheless, its findings suggest narcissists use Facebook to inflate their already puffed-up egos, while lonely people passively navigate it, observing the life that is passing them by. Perhaps both groups would be better off watching a good movie — say, *The Social Network.*

http://www.miller-mccune.com/culture-society/australian-study-links-facebook-use-with-narcissism-29129/

American Idolatry: So Bad You Just Gotta Be Good

Those tone-deaf belters humiliating themselves for our amusement help explain why we think we're better than the experts.

By Nate Kornell

If you absolutely know you have what it takes to be a star, you probably don't. Some "American Idol" contestants reflect what psychologists have long noted: that people without the skills to do an action well often don't have the skills to know they're doing it poorly. (FOX)

Here in Williamstown, Mass., where I live, there is a contractor who won't work with you if you watch shows about construction on HGTV. He simply got fed up with being told how to do his job by people who think they know what they're talking about but haven't got a clue.

Being unskilled is an obvious problem. But when we truly lack skill, we suffer a dual burden: We do not have the skills to perform well, and we don't even have the skill required to tell whether we're performing well or not. This problem affects us everywhere, in education, crime, politics, construction, government, relationships and beyond. It's particularly poignant during the first weeks of *American Idol*, which showcase two types of amazing singers: Great singers, and singers who are so terrible and tone-deaf that they think they're great.

Justin Kruger and David Dunning discussed this problem, which they call being "unskilled and unaware," in a classic article. They begin with an amazing story:

"In 1995, McArthur Wheeler walked into two Pittsburgh banks and robbed them in broad daylight, with no visible attempt at disguise. He was arrested later that night, less than an hour after videotapes of him taken from surveillance cameras were broadcast on the 11 o'clock news. When police later showed him the surveillance tapes, Mr. Wheeler stared in incredulity. 'But I wore the juice,' he mumbled. Apparently, Mr.

Wheeler was under the impression that rubbing one's face with lemon juice rendered it invisible to videotape cameras."

McArthur Wheeler made a terrible decision, but he also suffered from a failure of metacognition — that is, the ability to make judgments about one's own cognition. Deciding to rob a bank undisguised is a bad decision; that's a cognitive problem. Being so unskilled that one cannot tell good ideas from bad ideas is a metacognitive problem.

Kruger and Dunning found that the least skilled participants in their studies rated themselves just as highly as the best participants. In fact, when judging their ability to do logic problems, the bottom 25 percent of subjects judged themselves to be better than the middle 50 percent. Apparently, the best performers were justifiably confident and those in the middle group were good enough to recognize their own fallibility, but the worst performers were so bad they didn't even know they were bad.

The same thing happens on *American Idol*. The best singers are confident. The singers in the middle of the pack are less confident. But when we get to the bottom of the talent pyramid, confidence seems to surge up again. The worst singers are unaware that they are terrible, because they are too terrible to know it.

This may help explain why the most outraged losers on *American Idol* are sometimes the worst singers. If you have a tin ear and can't hear the difference between your squawking and Carrie Underwood, you'll probably be outraged to get cut.

Still, a question remains: Why do the worst *American Idol* contestants sometimes think they're the best? Having a tin ear should make you feel as good as everyone else. But why would it make you think you're better? One obvious reason is that the producers of *American Idol* only show us a small percentage of contestants who make good television (and unjustified outrage seems to make the cut). But there's something more fundamental at stake: People love themselves a little too much.

Human overconfidence has been demonstrated in myriad ways; for example, almost everyone thinks they are an above-average driver, when, of course, only 50 percent of us can be above average. We also think we're better than most people at lots of other well-practiced tasks, like using a computer mouse. We all seem to think we live in Lake Wobegon, where all of the children are above average.

Thus, there are two problems. First, when we are unskilled, we often lack the tools to recognize our own ineptness. Second, with no basis for judgment, overconfidence steps in to fill the void.

This problem is very widespread. For example, as I was writing this essay a few weeks back, I got a phone call saying our children's school was opening two hours late today because of cold weather. My first reaction was: If I ran that school, things would get done right! I literally shouted, "They're morons!" to my wife.

Of course, I know nothing about running a school. I'm not even skilled enough to know what the problems are, much less how to solve them (turns out the busses wouldn't start in -15 degree weather). But that didn't stop me. I interrupted writing a rant against being unskilled, unaware, and overconfident to be exactly that.

Of course I'm not unique. Most of us have thought, at some point about some group: "They're all morons! I'd do it much better!" This sentiment is especially popular when people think about their government. In fact, a number of new congresspeople were elected on the "They're Morons" platform in 2010.

But this is an attitude that we should be very careful about. Those of us who do not have experience running a government are unskilled, and we're probably just as unaware. We may be tone-deaf singers yelling about how we are so much better than those Washington insiders. Who, of course, used to yell about how much

better they were than the insiders who preceded them. Running a government requires experience and skill; most of us are unaware of what that skill is all about.

There are a million other examples. When fans yell at coaches for making terrible decisions, they're often unskilled, unaware and overconfident. When a student complains her D should have been an A because it's just as good as her friend's A paper, she is probably unable to see the difference between a good paper and what she produced (and this kind of complaint is not uncommon).

So, if you catch yourself feeling like you're pretty good at something despite your lack of experience, or if you want to give advice to an expert, or if you feel sure you could do a much better job of X than whoever is doing it, just make sure you check your skill level. If you're unskilled, chances are you might be so unskilled you don't even know how bad you are.

http://www.miller-mccune.com/culture-society/american-idolatry-so-bad-you-just-gotta-be-good-28198/

Don't Legalize Drugs, Decriminalize 'em

Portugal's example suggests that de-escalating the war on drugs might create a new sort of peace dividend.

By Michael Scott Moore

It may seem like semantics, but Portugal's experiment in decriminalizing drugs (lot legalizing them) has had some pretty impressive results. (Mark Wragg / istockphoto.com)

When Portugal took a leap into the unknown in 2000 and decriminalized drugs, people howled. Abuse would soar, they said, and the little nation on Europe's Iberian coast — already a summer dumping ground for drunken Germans and Brits — would become a haven for drug tourism.

"I am against liberalization of drugs," one conservative opposition leader in Portugal told a documentary maker at the time.

"Why?"

"Because I am against," he repeated. "I don't want the state giving signs of weakness [on] drug policy."

But in 2000, the Casal Ventoso slum in Lisbon — "20 hectares of hell you won't find in the tourist brochures," according to the same documentary — was already known as Europe's biggest drug bazaar. Heroin use, for example, was a crime; but people lined up for it on the street like American shoppers at Costco. Portugal's drug policy was not just weak but broken.

The solution wasn't "legalization." Even now you can't buy coke or heroin at a Portuguese corner store. It was decriminalization: People charged with drug abuse are treated medically for drug abuse, rather than thrown in jail.

Glenn Greenwald, the lawyer and columnist for Salon who wrote a 2009 study on the results of Portugal's experiment, said drug use in Portugal was "completely removed from the criminal sphere. … Instead, it's deemed to be an administrative offense only." And Brendan Hughes, at the European Monitoring Center for Drugs and Drug Addiction, clarified to *The Economist*, "Drug use remains illegal in Portugal, and anyone in possession will be stopped by the police, have the drugs confiscated and be sent before a commission," which then decides on treatment.

The results are impressive: A drop in HIV rates, a drop in street overdoses and a drop in overall drug abuse (except marijuana). People don't flock to Portugal from across Europe to abuse drugs. "The apocalypse never came," Brendan Hughes said. And Casal Ventoso has converted from a slum into a working-class neighborhood.

Trafficking drugs is still a criminal offense. But now, to curb usage, Lisbon sends groups of medical counselors — not vice squads — to neighborhoods like Casal Ventoso, handing out sterile needles, condoms and bringing people in for help. A lot of people, it seems, would rather not be addicted. And when they're not criminalized, they don't mind being helped.

The most fascinating part of the policy is that no political party in Lisbon developed it. Portugal was not pushing through a "libertarian ideology based on the idea that adults should be able to use whatever substances they want," Greenwald told *Reason* magazine — dodging an opportunity himself to offer lip service to libertarianism, though he wrote the study for the Cato Institute.

"Nor was it because there's some idyllic upper-middle-class setting. Portugal is a very poor country" compared to the richer nations of Europe, he went on. "They were taking this step out of desperation. They convened a council of apolitical policy experts and gave them the mandate to determine which optimal policy approach would enable them to best deal with these drug problems."

It would be nice if someone in Washington could show enough level-headed sanity and courage to do the same. A Mexican drug war is lapping at the southern border of the United States in a way that communism never did, but no one (south of the U.S.-Canada border) has the guts to quell its driving force, which is the American lust for drugs. Meanwhile, the prisons fill up with "drug felons."

Whether Portugal's policy in America would be enough to end the Mexican violence is a question for a separate column; but treating drug abuse as a public-health problem would, at least, free up American tax money now spent on criminalizing people for their desires. Experience from around Europe shows that a public-health policy aimed at rehabilitating people — and even handing out clean syringes — is cheaper than throwing abusers in jail.

There are a few signs of thaw in the U.S., like the expansion of drug courts (also grist for another column). But the first step is changing the nation's vocabulary about drugs. It's all too easy to argue against "legalization" — to say we shouldn't do it, or to say no American politician could promote it and expect to have a career.

Fully legal heroin, paid for by Obamacare, as in Britain's National Health experiments? Or hash cafés in New Orleans, modeled on the ones in Amsterdam? Probably not!

But decriminalization is something else.

http://www.miller-mccune.com/politics/don%E2%80%99t-legalize-drugs-decriminalize-%E2%80%99em-29133/

Australians Have Learned to Drive Less

In car-crazy Australia, soft measures are turning the tide in the hard battle to reduce the number of basically empty cars on the road.

By Randy Salzman

Though it may not look it from this photo, in Australia, soft measures are turning the tide in the hard battle to reduce the number of cars on the road. (Tony Rodd / flickr.com)

With turmoil raging near Middle Eastern oil fields and December's Cancun climate summit failing to produce any binding agreement even though the Gulf of Mexico had suffered from the world's worst offshore oil spill, perhaps it's time to consider how America might honestly address its oil dependency and global warming issues.

Transportation, not industry or commerce, is the prime factor in the nation's consumption of petroleum and emission of greenhouse gases. American driving consumes over half of the nation's daily burn of 19 million barrels of oil and produces 45 percent of the entire world's automotive carbon dioxide emissions.

As Americans drive more than 2.9 trillion miles annually, spewing clouds of environmental, traffic, trade and security issues in their exhaust, there's remarkably little interest in changing habits.

Australia, a booming economy with a higher rate of car ownership than the United States and even more wide-open spaces, is a model for what we must do.

The "car culture Down Under," however, has turned the public acceptance corner and is building, with strong citizen support, seemingly expensive bike-pedestrian infrastructure, bus rapid transit and commuter rail with local, state and — only recently — federal dollars.

Infrastructure Australia allowed 2010 money to be spent on roads only if they primarily carried freight and set aside 55 percent of each federal transportation dollar for commuter rail. (In the United States, 80 percent of federal transportation money goes into highways — and that's before the $28 billion in stimulus dollars President Obama put into shovel-ready highway projects. Our total subsidy for roads was $145 billion in 2004, four times the subsidy for mass transit.)

Americans can be persuaded to drive less

Although lots of places in the United States sample bits and pieces of transportation management, Bellingham, Wash., shows what can happen by taking on the full program. Read about it here.

Australia still has freeways and suburbs, still has conflict between liberal and conservative parties, still has wide-open spaces, still has economic growth at the forefront of planning. And yet, led by dozens of "soft" transportation demand management (or TDM) projects in cities as diverse as Brisbane, Adelaide, Melbourne and Perth, it has found the key to moving individual transportation behavior away from the convenience of the single-occupancy vehicle.

In Perth, for example, after a decade of TDM educational marketing called TravelSmart, the state of Western Australia opened the Southern Suburbs Railway in December 2007. It was over budget and behind schedule — but saw 67,000 first-day riders and 90 percent approval ratings. Thirty years ago, Western Australia was closing commuter rail and building freeways in all directions.

Each TravelSmart project is different, but in general, the individualized educational programs provide whatever information and emotional support — like personal bicycle doctors or bus drivers to explain the schedule — to help any member of any marketed household change driving behavior on any trip, not just the commute trip. Printed materials are delivered by bicycle as TravelSmart practitioners practice what they preach.

Other psychological concepts, like "reciprocity," "creating community" and "bypassing adversaries," ensure that TravelSmart is only working with citizens willing to change while reassuring them of the societal value of their transportation behavioral change. In Brisbane's latest TravelSmart projects, the average cost is about $70 per household. (Budget divided by households in Aussie dollars)

In fall 2009, in the midst of finalizing a 324,000-home TravelSmart project, the state of Queensland opened a $63 million footbridge over the Brisbane River — just eight years after many citizens fought a $23 million footbridge less than a mile away. Brisbane's conservative mayor, Campbell Newman, while pledging $100 million for bike paths has cooperated with liberal state politicians and built a pair of "end of the road" cycling facilities that promise hot showers, laundry, bike repair and clean lockers to more than 1,000 bicycle commuters. In its first year, the $6.5 million King George Square Cycle Center saved 56,000 car-kilometers (35,000 car-miles) between the suburbs into the city, a Griffith University study shows.

The Australian experience is indicating clearly that "carrots, sticks and tambourines" — with TravelSmart being the tambourines — can decrease traffic and therefore lower congestion, pollution, greenhouse emissions and improve citizen health.

In 2006, Queensland planners discovered an amazing "diffusion" of TravelSmart materials designed to help drivers choose any other mode of transportation for any trip — not just a commute — in a 77,000-home project in the northern Brisbane suburbs. More than 100,000 households were using the brochures, maps, schedules, discount tickets and promotional information.

As Werner Brög, TravelSmart's German founder, puts it, "People want to be part of the solution. They just don't know how."

Indeed, Queensland is today spending $22.6 million to TravelSmart in the South Brisbane, Gold Coast and Sunshine Coasts suburbs because it is absolutely sure that "soft" transportation demand management marketing changes individual behavior by re-acquainting receptive citizens with bicycles and buses.

Brisbane hopes to reap the same benefits that the 1.6 million people in and around Perth did after its decade of TravelSmart. Western Australia finds that annually TravelSmart marketing is decreasing car starts by 30 million and carbon emissions by 88 million tons while increasing transit boardings by 4.2 million and physical fitness hours by 7 million — every year.

For the first several years of Australian TDM projects, academic critics argued that individualized marketing data was not "reliable" because of difficulty duplicating it. Every TravelSmart operative, for example, is encouraged to say whatever he or she wants as long as there is no coercion. Hence, with no "script" to analyze as a study variable, academic researchers couldn't re-create the marketing model and illustrate similar results.

But after early critic Peter Stopher of the University of Sydney used GPS units to "meter" drivers in Adelaide over a three-year period and discovered an 18 percent reduction in vehicle kilometers driven if the household had been individually marketed — greater results than Brög had ever claimed — every major urban area in Australia except Sydney is utilizing TravelSmart today.

Sydney, where mass transit is already maxed, has avoided using TravelSmart out of fears it will create demand for public transportation that it can't supply.

In 2004, the OECD nations published "Communicating Environmentally Sustainable Transport," which underlines the issue. The prime benefit of "soft measures" like TravelSmart, the conference proceedings note, is improved acceptance of "hard measures" — like taxes and expensive infrastructure, the "carrots and sticks" of TDM. The "carrots," like Brisbane's cycleways, cycle centers and world-class busways program, have only come in tandem with the public hearing the tambourines.

Today, as the Perth-area has expanded the individualized concept into energy usage, water savings and recycling, about 80 percent of citizens want to hear, and see, more information on changing their own behavior to benefit society.

Perhaps most importantly, Australians are today willing to back expensive alternative transportation infrastructure with their tax dollars — even if it's infrastructure they don't personally think they will use.

http://www.miller-mccune.com/environment/australians-have-learned-to-drive-less-29207/

The Invisible Hate Crime

Hate crimes against people with disabilities are widespread and often involve extraordinary levels of sadism. The first step in combating these shameful incidents is an acknowledgment that they exist.

By Jack Levin

Few Americans are aware of the special vulnerability of people with emotional, intellectual and physical disabilities to extraordinary violence. (Illustration by Jeff Bennett)

In February 2010, Jennifer Daugherty, a 30-year-old, mentally challenged woman from Greensburg, Pa., was brutally murdered by six people pretending to be her good friends. Holding her hostage for days, the perpetrators allegedly tortured Daugherty, shaving her head, binding her with Christmas decorations, beating her with a towel rack and vacuum cleaner, feeding her detergent, urine and various medications and then forcing her to write a suicide note, before stabbing her to death.

The sadistic attack on Daugherty was anything but unique. Still, few Americans are aware of the special vulnerability of people with emotional, intellectual and physical disabilities to extraordinary violence. Thinking of crimes inspired by hate or bias, most people conjure an image of a burning cross on the lawn of a black family, or swastikas scrawled on the walls of a synagogue. They may recall the name of James Byrd, the black American in Jasper, Texas, who was dragged for miles to his death behind a pickup truck by three white supremacists, or they might think of Matthew Shepard, the gay college student who was viciously beaten and then tied to a fence, left to die in the desert outside of Laramie, Wyo.

But the same Americans may have legal and emotional "tunnel vision," not seeing a hate crime in the brutal murder of Jennifer Daugherty, even though she was apparently singled out only because of her intellectual deficit.

Thirty-two states have hate crime statutes to protect people who have disabilities, but 18 states still do not. At the end of October 2009, President Obama signed the Matthew Shepard and James Byrd, Jr. Hate Crimes

Prevention Act, bringing a uniform approach to the protection of hate crime victims that was not possible when matters were left to the states. The Shepard/Byrd legislation expanded federal hate crimes law to include offenses motivated by a victim's disability, gender, sexual orientation and gender identity. In addition, the new law eliminated a requirement that hate crime victims be engaged in a federally protected activity — for example, the right to live in the residence of your choice — to qualify for protection.

Still, attacks on people with disabilities are often overlooked because many people are not aware of the extreme vulnerability to maltreatment that accompanies such disorders as cerebral palsy, autism, multiple sclerosis, learning disabilities and mental illness — even though, according to anonymous victim accounts from the Bureau of Justice Statistics, the 54 million Americans with disabilities experience serious violence at a rate nearly twice that of the general population. Their risk of being a victim of sexual assault is at least four times higher than that of people without disabilities. In 2008 alone, Americans with disabilities were victims of about 47,000 rapes, 79,000 robberies, 114,000 aggravated assaults and 476,000 simple assaults. Adding to the trauma of victimization, people with disabilities are much less likely than able-bodied victims to seek medical treatment for their injuries, often choosing, instead, to suffer in silence.

Over the years, police departments around the country have increased their sensitivity to hate crimes based on race, religion or sexual orientation, but they still may not recognize bias against disabilities as a motivation for an assault. For the year 2009, just 97 or about 1 percent of the 7,789 hate crimes recognized by the police in FBI data reportedly targeted people with disabilities. (Of that total, 72 reports were designated as anti-mental disability crimes, and 25 were anti-physical disability crimes). This appears to represent a tremendous underestimate. When it surveyed nationally representative individuals anonymously about their experiences with crimes — even offenses not reported to the police — the Department of Justice determined that more than 11 percent of all hate crimes targeted people with disabilities. In other words, by asking victims rather than the police, the Justice Department found the number of disablist attacks numbered in the thousands.

And that's not to mention another problem: Hate offenses are underreported, generally.
The FBI hate crime count is based on a voluntary reporting system that many local police jurisdictions refuse to support. In 2009, for example, only nine hate crimes were reported for the entire state of Alabama, which would reflect just one such crime per 523,190 citizens, according to Census Bureau population estimates. By contrast, other states have typically reported a much higher rate of hate crimes — for example, Massachusetts reported 322 in 2009, a rate of one for every 20,476 citizens, and New Jersey had 549 reported hate crimes, reflecting a 1-in-16,000 rate. It is hard to imagine such a huge divergence in rates arising out of anything but different reporting standards — and, perhaps, different levels of enthusiasm for reporting hate crimes at all.

Hate crimes are also underreported because motivation is a central element, and motives are often difficult to prove. The perpetrators might not have used a slur or written hate graffiti on a wall or sidewalk; they might never have confided their intent to the police or an acquaintance.

(Source: Crime Victimization Survey, U.S. Department of Justice)

In July 2006, for example, Steven Hoskin, a 39-year-old man with severe learning difficulties who lived in a small English village, was violently tortured for hours in July 2006 by five people — three young adults and two teenagers — before he was forced to take dozens of painkillers and then pushed from a viaduct to his death. Pretending to be Hoskin's friends for several months before the fatal incident occurred, the five young perpetrators bullied their victim into submission on a number of occasions. The victim became convinced that he was being included as a member of a "gang" and was willing to endure pain and suffering to remain in good standing with his "good friends." The torture and murder of Steven Hoskin had no economic motive. The crime would have been impossible if Hoskin had had normal intellect. But proving that the attack was motivated by the victim's disability is not easy to do.

For many reasons, victims are themselves underreporters of hate offenses. Based on a history of animosity, black and Latino victims may see law enforcement as an "army of occupation"; immigrants may identify the police with a tyrannical regime in their home country or be concerned about being deported; gays and lesbians may perceive, rightly or not, that police officers are generally homophobic.

But violence against people with disabilities differs in important ways from other hate crimes, making attacks even less likely to be reported or acknowledged. Unlike racially and religiously motivated offenses, attacks against people with disabilities tend to be committed not by strangers but, more often, by family members, neighbors, employees and friends who may also be caregivers.

In January 1999, eight men and women tortured a 23-year-old man with learning disabilities who worked as a cook at a fast-food restaurant in Tinton Falls, N.J. Apparently imitating the horror movie *Scream*, which they had recently viewed, the group persuaded the victim to attend a "party" and, when he arrived, tormented him for almost three hours. They stripped their victim to his underwear, slapped and kicked him and taped him to a chair that they dragged around the room. One perpetrator attempted to shave the victim's eyebrows and head with a razor; another completed the job with electric hair clippers. Members of the group then whipped him with rope knotted with a series of plastic beads, so his naked back, face and chest were covered by a network of cuts and bruises.

Cutting their victim out of the chair, they forced him to wear a bra and a woman's suit and dragged him into a van, driving him into the woods. Upon reaching a desolate area, they repeatedly punched him and slammed him to the ground. Finally, the victim was able to escape. He staggered to a nearby property, where he convinced a security guard to summon the police, who drove him to a local hospital where he was treated and released.

The victim wanted desperately to be accepted by his tormentors. Two weeks earlier, he had attended a party with the same perpetrators, who abused him and held him hostage for the evening. But he didn't file charges at the time and instead was willing to attend a second party with the same group a couple of weeks later. Even after charges of kidnapping and aggravated charges were brought against his tormentors, the victim didn't seem to appreciate the brutality of the attack, telling reporters that he "just wanted to make friends with these people."

Victims with disabilities are often extremely reluctant to report attacks out of fear that their tormentors will retaliate. They may have psychiatric or intellectual deficits that seriously interfere with their capacity to recognize false friendships or to report crime. Or they may assume a position of dependence in a relationship with caretakers who conceal their sadistic urges in the high credibility of their institutional roles. In October 2008, for example, five staff members in a Louisiana psychiatric facility were arrested for allegedly battering their patients with hand weights and inserting bleach into their open wounds. The victimized patients had complained bitterly but were perceived to be out of touch with reality and undeserving of being taken seriously.

Ignoring such hate offenses is particularly unfortunate because the level of sadism and brutality is frequently greater than in their racial and religious counterparts, and their perpetrators often engage in the sort of overkill not usually found in attacks based on other kinds of bias.

Slurs used by offenders represent the most widely employed evidence for establishing the commission of a hate attack. Racial and religious epithets are widely recognized, even by those individuals who themselves would never use them and are repulsed by those who do. The nasty labels placed on people with disabilities are just as hurtful as their racial and religious counterparts but are not recognized to the same extent. People with disabilities have been referred to as invalids (i.e., not valid persons), handicapped (capable only of begging, cap in hand) or disabled (incompetent). Other hurtful labels include crippled, deformed, feeble-

minded, idiot, moron, imbecile, insane, lunatic and maniac. Often, people who wouldn't dream of using the N-word feel free to refer to an intellectually challenged individual as a "retard."

As a cultural phenomenon, racist preferences apparently find inspiration early in life, as children begin to develop the biases that they have learned from dinner table conversations, family members, friends and television programs. In an early study by social psychologists Kenneth and Mamie Clark, preschool children were asked to choose either a black or a white doll to play with. The majority of both white and black children preferred to play with the white doll, indicating the early impact of racial subordination and segregation on the psyche of countless minority youngsters. Testimony about the Clark and Clark study was given in the landmark 1954 Supreme Court decision in *Brown v. Board of Education*, which mandated the desegregation of America's schools.

Negative perceptions of disability are also, it seems, formed very early in life. Most children aged 3 to 6 are already aware of physical disabilities and have already attributed negative characteristics to those who are not physically able-bodied. Writing in the journal *Mental Retardation*, researcher Laura Nabors notes that when able-bodied preschool children were shown pictures of persons with and without disabilities, the preschoolers showed a marked preference for able-bodied playmates and an aversion to their physically challenged counterparts. Children are more likely to learn about psychiatric and intellectual deficits later, when their cognitive abilities have developed enough to think of people who are developmentally different in unflattering terms.

Over time, what began as an aversion may easily be transformed into outright prejudice and hate. From the viewpoint of a perpetrator, the members of an out-group — defined by their physical or developmental differences — may represent a threat to his or her economic well-being, to cultural or religious values, to neighborhood composition, to educational opportunities and even to physical survival. What we might view as a hate crime is therefore often regarded by a perpetrator as *self-defense*. Hate attacks, therefore, usually occur after some precipitating event — a gay rights rally, the first Latino in a college dormitory, a developmentally delayed student mainstreamed into a regular classroom — that is seen as calling for a "last resort" response.

As with members of racial and religious groups, individuals with disabilities have often been the victims of such "defensive" hate crimes. A couple in suburban Chicago, both of whom were dependent on wheelchairs, planned to install a ramp at the entrance of their single-family residence — until neighbors threw rocks through their windows and sent threatening letters saying, "Your kind won't last here." The couple gave up and moved away. They might have stayed in their home had they received support and encouragement from neighbors and the police; they did not.

Many hate crimes are committed by groups of young people — teenagers or young adults — who, bored and idle, are looking for a little excitement at someone else's expense. Such *thrill* hate attacks bring few practical gains to their perpetrators. Instead, they get an intangible benefit: bragging rights with friends who think that hate and violence are pretty cool. Thrill crimes are usually directed by a sadistic leader who has tremendous influence over a group of friends who may not be hate-filled but are all too eager to be accepted.

In May 2010, a 19-year-old high school student with a developmental disability was brutally attacked on a busy Boston street, in broad daylight, by a group of nine young people, ages 15 to 21. The bloodied victim, who later described himself to police as "slow and challenged," screamed and pleaded for help, then curled up on the ground, as the perpetrators repeatedly kicked, beat and choked him. The victim later told police that "the kids up the street had jumped him." He had known his assailants from the Dorchester Youth Collaborative — an agency for high-risk teenagers — and they did not like him. But the youthful perpetrators used their shared animosity as a bonding exercise. The more they shared in bashing their victim, the more cohesive their friendships became.

Some of the most dangerous hate crimes have a retaliatory motive, encouraging "tit for tat" in an exchange of violence. When the motive is retaliatory, an original attack by the members of one group is met by a retaliatory attack, often on a random basis, by the members of the victim's group. In other words, the victim becomes the villain.

On Jan. 19, 2007, John Odgren stabbed to death his 15-year-old schoolmate — a random victim — in a restroom at Lincoln-Sudbury Regional High School in Massachusetts. The 16-year-old killer had been diagnosed, early on, with major depression, Asperger's Syndrome, attention deficit hyperactivity disorder and obsessive-compulsive disorder. Because of his disabilities, Odgren had a long history of having been bullied and having sought to retaliate violently. In third grade, he threatened to shoot some girls who had harassed him. In fourth grade, he jabbed a pencil into another student's chest. He was bullied repeatedly as he bounced from school to school and finally got even with his mainstreamed peers by killing an innocent victim. For taking the life of his schoolmate, Odgren was tried, convicted of first-degree murder and sentenced to life in prison without parole eligibility.

It is important to acknowledge that some organized hate groups overtly display their hostility to disabled people in a manner that encourages nonmembers to become violent. In early November 2002, for example, the white supremacist group Stormfront allocated a section of its Web discussion forum to eugenics. Among the comments presented online was the following: "We must put into place social and economic systems that encourage the best genes to dominate in numbers as well as power."

But only a very small minority of hate crimes — perhaps 5 percent — directly involve organized hate groups. Disability hate crimes are no different in this respect.

Victims of disablist violence learn to respond in any of a number of ways to the maltreatment they are forced to endure in their day-to-day lives. In the face of widespread bias, some people with disabilities come to accept the nasty stereotypes being communicated widely about them and suffer a profound loss of self-esteem. They may see themselves as inferior, incompetent, totally disabled. Rather than regard their disability as only one of many characteristics they possess, they may instead come to define themselves totally by their most serious disadvantage and give up the struggle for self-improvement, sinking deeply into depression, drug abuse or alcoholism.

Other people with disabilities refuse to accept the nasty stereotypes that invade their lives, instead seeking to avoid the nastiest implications of their maltreatment by segregating themselves in terms of friendship, employment and dating. Rather than give up, they attempt to insulate themselves from the insulting behavior of the able-bodied.

Still others seek collectively to change the maltreatment they have suffered because of their disabilities. Since the 1970s, members of the disability rights movement have instituted boycotts, blocked traffic and engaged in a variety of protests, marches and sit-ins. Closely mirroring the civil rights and women's movements of the 1960s, organized efforts have aided in the passage of disability-rights laws and the blockage of policies that would have been hurtful to people with disabilities. In the last couple of years, hundreds of people in wheelchairs have demonstrated on the streets of Atlanta, Chicago, Washington D.C., and Nashville. In August 2008, the Special Olympics and 21 other disability groups called for a nationwide boycott of the Ben Stiller-directed film *Tropic Thunder* because of what the organizations considered a "negative portrayal" of the developmentally disabled.

Such collective efforts are important as models for what the victims of hate violence might be able to achieve in the future. For now, however, such demonstrations are typically designed to reduce employment discrimination or to discourage cuts in government budgets. The hate crime response has not yet occurred.

We don't have to change the law on hate crimes against people with disabilities — that has already happened — but we must change the thinking of ordinary people who consider only race, religion or sexual orientation as grounds for bigotry. Many people with disabilities are harmed more by the way others treat them than by their intellectual, psychiatric or physical disadvantages. This unfortunate fact has been widely ignored by otherwise decent Americans, who, when they think of hate crimes, tend to focus on people wearing sheets, armbands, steel-toe boots or Nazi tattoos. It is easy to forget that hate begins in the silence of ordinary people.

http://www.miller-mccune.com/legal-affairs/the-invisible-hate-crime-27984/

A 'Fossil Seismograph' for Ancient Earthquakes

Prof. Shmuel Marco at work. (Credit: Image courtesy of American Friends of Tel Aviv University)

ScienceDaily (Mar. 22, 2011) — Earthquakes are one of the world's biggest enigmas -- impossible to predict and able to wreak untold damage within seconds. Now, a new tool from Tel Aviv University may be able to learn from earthquakes of the ancient past to better predict earthquakes of the future.

Prof. Shmuel Marco of Tel Aviv University's Department of Geophysics and Planetary Sciences in the Raymond and Beverly Sackler Faculty of Exact Sciences and his colleagues have invented a new tool which he describes as a "fossil seismograph," to help geophysicists and other researchers understand patterns of seismic activity in the past.

Inspired by a strange "wave" phenomenon he studied in disturbed sediment in the Dead Sea region, Prof. Marco says the new tool, developed with input from geologists and physicists, is relevant to areas where earthquakes affect bodies of water, like the West Coast of the United States. It also can help engineers understand what's at risk when they plan new hydroelectric power plants. The new research was published in the journal *Geology*.

A geophysical yardstick for centuries past

"Current seismographical data on earthquakes only reaches back a century or so," says Prof. Marco. "Our new approach investigates wave patterns of heavy sediment that penetrates into the light sediments that lie directly on top of them. This helps us to understand the intensity of earthquakes in bygone eras -- it's a yardstick for measuring the impact factor of earthquakes from the past."

Prof. Marco, his departmental colleague Prof. Eyal Hefetz, and doctoral student Nadav Wetzer took a highly technical look at layers of mud at the Dead Sea. The layers were originally stratified in a very stable manner, but now heavier sediment appears to have been pulled up into the lighter sediment.

The researchers propose that the physics governing the sediment patterns is similar to a phenomenon found in clouds and sea waves but in the case of rocks it was the earthquake shaking (rather than wind) that triggered the formation of waves. The scientists call it the "Kelvin-Helmholtz Instability," which describes a theory of turbulence in fluids. The Tel Aviv University team applied this theory to analyze the deformation of sediment caused by past earthquakes.

Earthquakes cause deformation in rocks and sediment. Using the basic principles of friction, the researchers considered the geometry of the shapes they found in the Dead Sea sediment and combined it with a number of other parameters found in physical science to calculate how earthquakes from the past were distributed in scale, time and place.

The bigger geological picture

Prof. Marco and his colleagues found that the deformation begins as moderate wave-like folds, evolves into complex recumbent folds, and finally exhibit instability and fragmentation. The deformation process advances depending on the earthquake size -- the stronger the earthquake, the more intense the deformation.
The seismological record for fault lines like those near Jerusalem and Los Angeles simply isn't old enough to predict when the next quake might strike. "We've expanded the window of observation beyond 100 years, to create, if you will, a 'fossil seismograph,'" says Prof. Marco. He adds that the tool is only relevant in earthquake zones that intersect with bodies of water such as lakes or the sea.
But it could be very relevant to geologists studying earthquake patterns in areas like the Salton Sea in Colorado. The Salton Sea, only 100 years old, is located directly on the San Andreas Fault in California's Border Region.

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

Journal Reference:

1. N. Wetzler, S. Marco, E. Heifetz. **Quantitative analysis of seismogenic shear-induced turbulence in lake sediments**. *Geology*, 2010; 38 (4): 303 DOI: 10.1130/G30685.1

http://www.sciencedaily.com/releases/2011/03/110314111224.htm

Forensics: Overweight People Really Are Big-Boned

Researchers found that the heavier an individual was, the wider the shaft of that person's femur. (Credit: Image courtesy of North Carolina State University)

ScienceDaily (Mar. 22, 2011) — One of the blind spots in forensic science, particularly in identifying unknown remains, is the inability of experts to determine how much an individual weighed based on his or her skeleton. New research from North Carolina State University moves us closer to solving this problem by giving forensic experts valuable insight into what the shape of the femur can tell us about the weight of an individual.

"This research allows us to determine whether an individual was overweight based solely on the characteristics of a skeleton's femur, or thigh bone," says Dr. Ann Ross, an associate professor of anthropology at NC State and co-author of a paper describing the research. However, Ross notes, this research does not give us the ability to provide an individual's exact weight based on skeletal remains.

Researchers found that the heavier an individual was, the wider the shaft of that person's femur. The researchers hypothesize that the femur of an overweight person is more robust because it bears more weight, but also because overweight individuals move and walk differently to compensate for their greater mass.

The researchers evaluated the femur bones of 121 white men for the study. They used the bones of white men exclusively in order to eliminate any variation that could be attributed to race or gender.

NC State's Department of Sociology and Anthropology is part of the university's College of Humanities and Social Sciences.

Story Source:

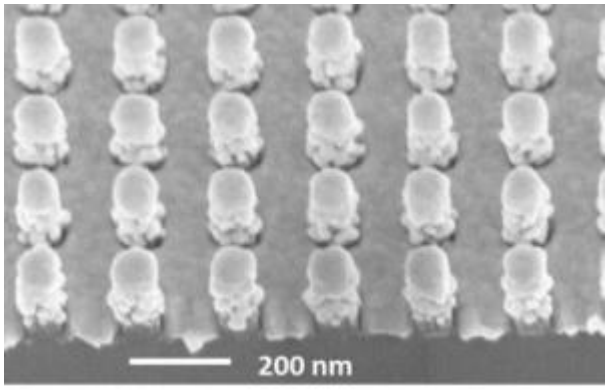
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **North Carolina State University**.

Journal Reference:

1. Gina M. Agostini, Ann H. Ross. **The Effect of Weight on the Femur: A Cross-Sectional Analysis**. *Journal of Forensic Sciences*, 2011; 56 (2): 339 DOI: 10.1111/j.1556-4029.2010.01648.x

http://www.sciencedaily.com/releases/2011/03/110322105300.htm

Engineers Make Breakthrough in Ultra-Sensitive Sensor Technology



Micrograph of a sensor developed at Princeton for sensing Raman scattering. Pillars support metal components that gather light and amplify Raman signals, wavelengths of light that can be used to identify a substance. (Credit: Stephen Y. Chou)

ScienceDaily (Mar. 22, 2011) — Princeton researchers have invented an extremely sensitive sensor that opens up new ways to detect a wide range of substances, from tell-tale signs of cancer to hidden explosives.

The sensor, which is the most sensitive of its kind to date, relies on a completely new architecture and fabrication technique developed by the Princeton researchers. The device boosts faint signals generated by the scattering of laser light from a material placed on it, allowing the identification of various substances based on the color of light they reflect. The sample could be as small as a single molecule.

The technology is a major advance in a decades-long search to identify materials using Raman scattering, a phenomena discovered in the 1920s by an Indian physicist, Chandrasekhara Raman, where light reflecting off an object carries a signature of its molecular composition and structure.

"Raman scattering has enormous potential in biological and chemical sensing, and could have many applications in industry, medicine, the military and other fields," said Stephen Y. Chou, the professor of electrical engineering who led the research team. "But current Raman sensors are so weak that their use has been very limited outside of research. We've developed a way to significantly enhance the signal over the entire sensor and that could change the landscape of how Raman scattering can be used."

Chou and his collaborators, electrical engineering graduate students, Wen-Di Li and Fei Ding, and post-doctoral fellow, Jonathan Hu, published a paper on their innovation in February in the journal *Optics Express*. The research was funded by the Defense Advance Research Projects Agency.

In Raman scattering, a beam of pure one-color light is focused on a target, but the reflected light from the object contains two extra colors of light. The frequency of these extra colors are unique to the molecular make-up of the substance, providing a potentially powerful method to determine the identity of the substance, analogous to the way a finger print or DNA signature helps identify a person.

Since Raman first discovered the phenomena -- a breakthrough that earned him Nobel Prize -- engineers have dreamed of using it in everyday devices to identify the molecular composition and structures of substances, but for many materials the strength of the extra colors of reflected light was too weak to be seen even with the most sophisticated laboratory equipment.

Researchers discovered in the 1970s that the Raman signals were much stronger if the substance to be identified is placed on a rough metal surface or tiny particles of gold or silver. The technique, known as surface enhanced Raman scattering (SERS), showed great promise, but even after four decades of research has proven difficult to put to practical use. The strong signals appeared only at a few random points on the sensor surface, making it difficult to predict where to measure the signal and resulting in a weak overall signal for such a sensor.

Abandoning the previous methods for designing and manufacturing the sensors, Chou and his colleagues developed a completely new SERS architecture: a chip studded with uniform rows of tiny pillars made of metals and insulators.

One secret of the Chou team's design is that their pillar arrays are fundamentally different from those explored by other researchers. Their structure has two key components: a cavity formed by metal on the top and at the base of each pillar; and metal particles of about 20 nanometers in diameter, known as plasmonic nanodots, on the pillar wall, with small gaps of about 2 nanometers between the metal components.
The small particles and gaps significantly boost the Raman signal. The cavities serve as antennae, trapping light from the laser so it passes the plasmonic nanodots multiple times to generate the Raman signal rather than only once. The cavities also enhance the outgoing Raman signal.
The Chou's team named their new sensor "disk-coupled dots-on-pillar antenna-array" or D2PA, for short.
So far, the chip is a billion times (109) more sensitive than was possible without SERS boosting of Raman signals and the sensor is uniformly sensitive, making it more reliable for use in sensing devices. Such sensitivity is several orders of magnitude higher than the previously reported.
Already, researchers at the U.S. Naval Research Laboratory are experimenting with a less sensitive chip to explore whether the military could use the technology pioneered at Princeton for detecting chemicals, biological agents and explosives.
In addition to being far more sensitive than its predecessors, the Princeton chip can be manufactured inexpensively at large sizes and in large quantities. This is due to the easy-to-build nature of the sensor and a new combination of two powerful nanofabrication technologies: nanoimprint, a method that allows tiny structures to be produced in cookie-cutter fashion; and self-assembly, a technique where tiny particles form on their own. Chou's team has produced these sensors on 4-inch wafers (the basis of electronic chips) and can scale the fabrication to much larger wafer size.
"This is a very powerful method to identify molecules," Chou said. "The combination of a sensor that enhances signals far beyond what was previously possible, that's uniform in its sensitivity and that's easy to mass produce could change the landscape of sensor technology and what's possible with sensing."

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Princeton University, Engineering School**, via EurekAlert!, a service of AAAS.

Journal Reference:

1. Wen-Di Li, Fei Ding, Jonathan Hu, Stephen Y. Chou. **Three-dimensional cavity nanoantenna coupled plasmonic nanodots for ultrahigh and uniform surface-enhanced Raman scattering over large area**. *Optics Express*, 2011; 19 (5): 3925 DOI: 10.1364/OE.19.003925

http://www.sciencedaily.com/releases/2011/03/110321134621.htm

Fish Know to Avoid the Spear

A Papua New Guinean spear fisherman loading a rifle-style spear gun at the surface. These spear guns are normally hand carved wooden stocks with rubber slings that fire a thin metal rod that has been hand sharpened. (Credit: Image courtesy of ARC Centre of Excellence in Coral Reef Studies)

ScienceDaily (Mar. 22, 2011) — Fish are not as dumb as people sometimes think. Marine scientists have found that fish that are regularly hunted with spearguns are much more wary and keep their distance from fishers.

In investigating the effects of marine areas closed to fishing by customary laws, an international team of researchers working in the Pacific found that fish exposed to speargun fishing take flight much earlier when a diver approaches compared with those living in protected zones.

To assess the effectiveness of marine protected areas and their effects on fish behaviour, the team decided to measure 'flight distance' in a range of coral reef fishes which are popular targets for local fishermen in the study area in Papua New Guinea.

"We were studying the effect of the customary reef closures which many groups in the Pacific use," explains team member Fraser Januchowski-Hartley of the ARC Centre of Excellence for Coral Reef Studies at James Cook University and the Wildlife Conservation Society.

"In developed countries marine areas closed to fishing are a fairly recent idea -- but in the Pacific islands, people have been using them for generations, for traditional reasons."

One of the issues the team was interested in was whether the existence of a closed area changed the behavior of the fish inside it, compared to the behavior of fish outside the area.

Their study took place at Muluk in Papua New Guinea where the local chiefs close areas of reef to fishing, sometimes for several years at a time, whenever it seems the fish are becoming a bit shy. The study looked at fish traditionally hunted by the local people including snappers, triggerfish, parrotfish and surgeonfish.

To study the fishes' flight distance, a scuba diver slowly approached the fish and dropped a marker at the point where the diver was when the fish was seen to take flight -- and a second marker at the point on the reef where the fish was when it fled. This enabled them to measure the distances at which fish fled from the diver, both inside and outside the protected area.

"Fish which are regularly targeted appeared to have a pretty fair idea of the 3m range of the typical rifle-style speargun used by the local PNG fishers," explains lead author Dr David Feary of University of Technology Sydney (UTS).

"Inside protected areas, the fish tended to move off when the diver closed to within 2-3 metres of them. However those outside the protected zone, where hunting was common, mostly fled when the diver came within 4-5 metres of them."

"Quite simply, the fish in areas that were fished regularly were warier and stayed further away- just far enough that it would be difficult to hit them with the spear gun technology used locally"

In the most extreme case, fish in unprotected areas had a flight distance 2.6 metres greater than the same species of fish in a protected zone -- putting them well outside the range of the spear.

However when an area was closed, the fish appeared to recover their confidence, allowing divers to approach much closer -- within speargun range when the area was reopened for fishing.
Feary explains "Sometimes these types of closures are used to create a 'bank account' of resources that are saved up for important cultural ceremonies. It seems that by closing the area off, communities may not only build up the amount of fish in the area, but make them easier to catch, which helps meet the goal of having fish for a feast. But this may pose a problem where temporary closures are used for conservation rather than community goals."
"Our results highlight a previously unconsidered mechanism through which a rapid and large decline in fish biomass may occur when a closed area is reopened to fishing; reduced flight distance resulting from protection may increase some fish species' susceptibility to spear fishing," Januchowski-Hartley cautioned.
They argue that while temporary closures have value in conserving fish stocks and helping them to recover, their effect on fish behaviour may have to be factored in when reserves are reopened, if the aim is to preserve fish stocks. This may entail the use of gear-restrictions or short re-openings to avoid a sudden, heavy kill of larger fish which have become accustomed to the relative safety of a closed area.
Their paper appears in the journal *Conservation Biology*.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **ARC Centre of Excellence in Coral Reef Studies**.

Journal Reference:

1. David A. Feary, Joshua E. Cinner, Nicholas A. J. Graham, Fraser A. Januchowski-Hartley. **Effects of Customary Marine Closures on Fish Behavior, Spear-Fishing Success, and Underwater Visual Surveys**. *Conservation Biology*, 2010; DOI: 10.1111/j.1523-1739.2010.01613.x

http://www.sciencedaily.com/releases/2011/03/110321134724.htm

Seeing in Stereo: Engineers Invent Lens for 3-D Microscope

A lens invented at Ohio State University enables microscopes to capture 3-D images of tiny objects. (Credit: Photo by Kevin Fitzsimons, courtesy of Ohio State University.)

ScienceDaily (Mar. 22, 2011) — Engineers at Ohio State University have invented a lens that enables microscopic objects to be seen from nine different angles at once to create a 3-D image.

Other 3-D microscopes use multiple lenses or cameras that move around an object; the new lens is the first single, stationary lens to create microscopic 3-D images by itself.

Allen Yi, associate professor of integrated systems engineering at Ohio State, and postdoctoral researcher Lei Li described the lens in a recent issue of the *Journal of the Optical Society of America A*.

Yi called the lens a proof of concept for manufacturers of microelectronics and medical devices, who currently use very complex machinery to view the tiny components that they assemble.

Though the engineers milled their prototype thermoplastic lens on a precision cutting machine, the same lens could be manufactured less expensively through traditional molding techniques, Yi said.

"Ultimately, we hope to help manufacturers reduce the number and sizes of equipment they need to miniaturize products," he added.

The prototype lens, which is about the size of a fingernail, looks at first glance like a gem cut for a ring, with a flat top surrounded by eight facets. But while gemstones are cut for symmetry, this lens is not symmetric. The sizes and angles of the facets vary in minute ways that are hard to see with the naked eye.

"No matter which direction you look at this lens, you see a different shape," Yi explained. Such a lens is called a "freeform lens," a type of freeform optics.

Freeform optics have been in use for more than a decade. But Lei Li was able to write a computer program to design a freeform lens capable of imaging microscopic objects.

Then Yi and Li used a commercially available milling tool with a diamond blade to cut the shape from a piece of the common thermoplastic material polymethyl methacrylate, a transparent plastic that is sometimes called acrylic glass. The machine shaved bits of plastic from the lens in increments of 10 nanometers, or 10 billionths of a meter -- a distance about 5,000 times smaller than the diameter of a human hair.

The final lens resembled a rhinestone, with a faceted top and a wide, flat bottom. They installed the lens on a microscope with a camera looking down through the faceted side, and centered tiny objects beneath the flat side.
Each facet captured an image of the objects from a different angle, which can be combined on a computer into a 3-D image.
The engineers successfully recorded 3-D images of the tip of a ballpoint pen -- which has a diameter of about 1 millimeter -- and a mini drill bit with a diameter of 0.2 millimeters.
"Using our lens is basically like putting several microscopes into one microscope," said Li. "For us, the most attractive part of this project is we will be able to see the real shape of micro-samples instead of just a two-dimensional projection."
In the future, Yi would like to develop the technology for manufacturers. He pointed to the medical testing industry, which is working to shrink devices that analyze fluid samples. Cutting tiny reservoirs and channels in plastic requires a clear view, and the depths must be carved with precision.
Computer-controlled machines -- rather than humans -- do the carving, and Yi says that the new lens can be placed in front of equipment that is already in use. It can also simplify the design of future machine vision equipment, since multiple lenses or moving cameras would no longer be necessary.
Other devices could use the tiny lens, and he and Li have since produced a grid-shaped array of lenses made to fit an optical sensor. Another dome-shaped lens is actually made of more than 1,000 tiny lenses, similar in appearance to an insect's eye.
This research was sponsored by the National Science Foundation. Moore Nanotechnology Systems in Keene, NH, provided the ultraprecision milling machine.

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

Journal Reference:

1. Lei Li, Allen Y. Yi. **Design and fabrication of a freeform prism array for 3D microscopy**. *Journal of the Optical Society of America A*, 2010; 27 (12): 2613 DOI: 10.1364/JOSAA.27.002613

http://www.sciencedaily.com/releases/2011/03/110321134625.htm

Templated Growth Technique Produces Graphene Nanoribbons With Metallic Properties

Georgia Tech graduate students Yike Hu and John Hankinson observe a high-temperature furnace used to produce epitaxial graphene on a silicon carbide wafer. A new "templated growth" technique allows fabrication of nanoribbons with smooth edges and high conductivity. (Credit: Georgia Tech Photo: Gary Meek)

ScienceDaily (Mar. 22, 2011) — A new "templated growth" technique for fabricating nanoribbons of epitaxial graphene has produced structures just 15 to 40 nanometers wide that conduct current with almost no resistance. These structures could address the challenge of connecting graphene devices made with conventional architectures -- and set the stage for a new generation of devices that take advantage of the quantum properties of electrons.

"We can now make very narrow, conductive nanoribbons that have quantum ballistic properties," said Walt de Heer, a professor in the School of Physics at the Georgia Institute of Technology. "These narrow ribbons become almost like a perfect metal. Electrons can move through them without scattering, just like they do in carbon nanotubes."

De Heer was scheduled to discuss recent results of this graphene growth process March 21st at the American Physical Society's March 2011 Meeting in Dallas. The research was sponsored by the National Science Foundation-supported Materials Research Science and Engineering Center (MRSEC).

First reported Oct. 3 in the advance online edition of the journal Nature Nanotechnology, the new fabrication technique allows production of epitaxial graphene structures with smooth edges. Earlier fabrication techniques that used electron beams to cut graphene sheets produced nanoribbon structures with rough edges that scattered electrons, causing interference. The resulting nanoribbons had properties more like insulators than conductors.

"In our templated growth approach, we have essentially eliminated the edges that take away from the desirable properties of graphene," de Heer explained. "The edges of the epitaxial graphene merge into the silicon carbide, producing properties that are really quite interesting."

The "templated growth" technique begins with etching patterns into the silicon carbide surfaces on which epitaxial graphene is grown. The patterns serve as templates directing the growth of graphene structures, allowing the formation of nanoribbons and other structures of specific widths and shapes without the use of cutting techniques that produce the rough edges.

In creating these graphene nanostructures, de Heer and his research team first use conventional microelectronics techniques to etch tiny "steps" -- or contours -- into a silicon carbide wafer whose surface has been made extremely flat. They then heat the contoured wafer to approximately 1,500 degrees Celsius, which initiates melting that polishes any rough edges left by the etching process.

Established techniques are then used for growing graphene from silicon carbide by driving off the silicon atoms from the surface. Instead of producing a consistent layer of graphene across the entire surface of the

wafer, however, the researchers limit the heating time so that graphene grows only on portions of the contours.

The width of the resulting nanoribbons is proportional to the depth of the contours, providing a mechanism for precisely controlling the nanoribbon structures. To form complex structures, multiple etching steps can be carried out to create complex templates.

"This technique allows us to avoid the complicated e-beam lithography steps that people have been using to create structures in epitaxial graphene," de Heer noted. "We are seeing very good properties that show these structures can be used for real electronic applications."

Since publication of the Nature Nanotechnology paper, de Heer's team has been refining its technique. "We have taken this to an extreme -- the cleanest and narrowest ribbons we can make," he said. "We expect to be able to do everything we need with the size ribbons that we are able to make right now, though we probably could reduce the width to 10 nanometers or less."

While the Georgia Tech team is continuing to develop high-frequency transistors -- perhaps even at the terahertz range -- its primary effort now focuses on developing quantum devices, de Heer said. Such devices were envisioned in the patents Georgia Tech holds on various epitaxial graphene processes.

"This means that the way we will be doing graphene electronics will be different," he explained. "We will not be following the model of using standard field-effect transistors (FETs), but will pursue devices that use ballistic conductors and quantum interference. We are headed straight into using the electron wave effects in graphene."

Taking advantage of the wave properties will allow electrons to be manipulated with techniques similar to those used by optical engineers. For instance, switching may be carried out using interference effects -- separating beams of electrons and then recombining them in opposite phases to extinguish the signals.

Quantum devices would be smaller than conventional transistors and operate at lower power. Because of its ability to transport electrons with virtually no resistance, epitaxial graphene may be the ideal material for such devices, de Heer said.

"Using the quantum properties of electrons rather than the standard charged-particle properties means opening up new ways of looking at electronics," he predicted. "This is probably the way that electronics will evolve, and it appears that graphene is the ideal material for making this transition."

De Heer's research team hopes to demonstrate a rudimentary switch operating on the quantum interference principle within a year.

Epitaxial graphene may be the basis for a new generation of high-performance devices that will take advantage of the material's unique properties in applications where higher costs can be justified. Silicon, today's electronic material of choice, will continue to be used in applications where high-performance is not required, de Heer said.

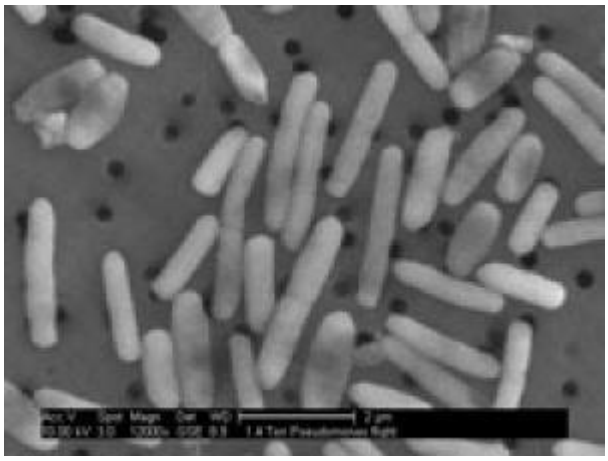
"This is an important step in the process," he added. "There are going to be a lot of surprises as we move into these quantum devices and find out how they work. We have good reason to believe that this can be the basis for a new generation of transistors based on quantum interference."

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Georgia Institute of Technology Research News**. The original article was written by John Toon.

http://www.sciencedaily.com/releases/2011/03/110321161916.htm

Spacebound Bacteria Inspire Earthbound Remedies



Scanning electron micrograph of Pseudomonas aeruginosa cultured on board Shuttle mission STS-115, as part of the MICROBE experiment (magnification 12,000X). (Credit: mage courtesy of Mayra Nelman-Gonzalez)

ScienceDaily (Mar. 21, 2011) — Recent research aboard the Space Shuttle is giving scientists a better understanding of how infectious disease occurs in space and could someday improve astronaut health and provide novel treatments for people on Earth.

The research involves an opportunistic pathogen known as *Pseudomonas aeruginosa*, the same bacterium that caused astronaut Fred Haise to become sick during the Apollo 13 mission to the moon in 1970.

Scientists studying the bacterium aboard the Shuttle hope to unlock the mysteries of how disease-causing agents work. They believe the research can lead to advanced vaccines and therapies to better fight infections.

The findings are based on flight experiments with microbial pathogens on NASA space shuttle missions to the station and appear in a recent edition of the journal *Applied and Environmental Microbiology*.

"For the first time, we're able to see that two very different species of bacteria -- *Salmonella* and *Pseudomonas* -- share the same basic regulating mechanism, or master control switch, that micro-manages many of the microbes' responses to the spaceflight environment," said Cheryl Nickerson, associate professor at the Center for Infectious Diseases and Vaccinology, the Biodesign Institute at Arizona State University (ASU) in Tempe. "We have shown that spaceflight affects common regulators in both bacteria that invariably cause disease in healthy individuals [*Salmonella*] and those that cause disease only in people with compromised immune systems [*Pseudomonas*]."

By studying the global gene expression patterns in bacterial pathogens like *Pseudomonas* and *Salmonella*, Nickerson's team learned more about how they react to reduced gravity.

Pseudomonas aeruginosa can coexist as a benign microbe in healthy individuals, but poses a serious threat to people with compromised immune systems. It is the leading cause of death for those suffering from cystic fibrosis and is a serious risk to burn victims. However, a high enough dosage of *Salmonella typhimurium* always will cause disease, even in healthy individuals.

During the initial study in 2006, two bacterial pathogens, *Salmonella typhimurium* and *Pseudomonas aeruginosa*, and one fungal pathogen, Candida albicans, were launched to the station aboard space shuttles. They were allowed to grow in appropriately contained vessels for several days. Nickerson's team was the first to evaluate global gene and protein expression (how the bacteria react at the molecular level) and virulence changes in microbes in response to reduced gravity.

"We discovered that aspects of the environment that microbes encountered during spaceflight appeared to mimic key conditions that pathogens normally encounter in our bodies during the natural course of infection, particularly in the respiratory system, gastrointestinal system and urogenital tract," Nickerson said. NASA's Advanced Capabilities Division Director, Benjamin Neumann added that, "This means that in addition to safeguarding future space travelers, such research may aid the quest for better therapeutics against pathogens here on Earth."

The initial study and follow-on space experiments show that spaceflight creates a low fluid shear environment, where liquids exert little force as they flow over the surface of cells. The low fluid shear environment of spaceflight affects the molecular genetic regulators that can make microbes more infectious. These same regulators might function in a similar way to regulate microbial virulence during the course of infection in the human body.
"We have now shown that spaceflight conditions modified molecular pathways that are known to be involved in the virulence of *Pseudomonas aeruginosa*," said Aurélie Crabbé, a researcher in Dr. Nickerson's lab at ASU and the lead author of the paper. "Future work will establish whether *Pseudomonas* also exhibits increased virulence following spaceflight as did *Salmonella*."

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

Journal Reference:

1. Crabbé A, Schurr MJ, Monsieurs P, Morici L, Schurr J, Wilson JW, Ott CM, Tsaprailis G, Pierson DL, Stefanyshyn-Piper H, Nickerson CA. **Transcriptional and proteomic responses of Pseudomonas aeruginosa PAO1 to spaceflight conditions involve Hfq regulation and reveal a role for oxygen.**. *Appl Environ Microbiol*, 2011 Feb;77(4):1221-30 [link]

http://www.sciencedaily.com/releases/2011/03/110321162007.htm

Primordial Soup Gets Spicier: 'Lost' Samples from Famous Origin of Life Researcher Shed New Light on Earth's First Life

Scripps Oceanography professor of Marine Chemistry Jeffrey Bada holds a preserved sample from a 1958 experiment done by "primordial soup" pioneer Stanley Miller. The residue in the sample contains amino acids created by the experiment. The samples had not undergone analysis until recently when Bada and colleagues discovered a wide range of amino acids using modern detection methods. (Credit: Scripps Institution of Oceanography, UC San Diego)

ScienceDaily (Mar. 21, 2011) — Stanley Miller gained fame with his 1953 experiment showing the synthesis of organic compounds thought to be important in setting the origin of life in motion. Five years later, he produced samples from a similar experiment, shelved them and, as far as friends and colleagues know, never returned to them in his lifetime.

More 50 years later, Jeffrey Bada, Miller's former student and a current Scripps Institution of Oceanography, UC San Diego professor of marine chemistry, discovered the samples in Miller's laboratory material and made a discovery that represents a potential breakthrough in the search for the processes that created Earth's first life forms.

Former Scripps undergraduate student Eric Parker, Bada and colleagues report on their reanalysis of the samples in the March 21 issue of *Proceedings of the National Academy of Sciences*. Miller's 1958 experiment in which the gas hydrogen sulfide was added to a mix of gases believed to be present in the atmosphere of early Earth resulted in the synthesis of sulfur amino acids as well as other amino acids. The analysis by Bada's lab using techniques not available to Miller suggests that a diversity of organic compounds existed on early planet Earth to an extent scientists had not previously realized.

"Much to our surprise the yield of amino acids is a lot richer than any experiment (Miller) had ever conducted," said Bada.

The new findings support the case that volcanoes -- a major source of atmospheric hydrogen sulfide today -- accompanied by lightning converted simple gases into a wide array of amino acids, which are were in turn available for assembly into early proteins.
Bada also found that the amino acids produced in Miller's experiment with hydrogen sulfide are similar to those found in meteorites. This supports a widely-held hypothesis that processes such as the ones in the laboratory experiments provide a model of how organic material needed for the origin of life are likely widespread in the universe and thus may provide the extraterrestrial seeds of life elsewhere.
Successful creation of the sulfur-rich amino acids would take place in the labs of several researchers, including Miller himself, but not until the 1970s.
"Unbeknownst to him, he'd already done it in 1958," said Bada.
Miller's initial experiments in the 1950s with colleague Harold Urey used a mixture of gases such as methane, ammonia, water vapor and hydrogen and electrically charged them as lightning would. The experiment, which took place in a closed chamber meant to simulate conditions on early Earth, generated several simple amino acids and other organic compounds in what became known as "primordial soup."
With the gases and electrical energy they produce, many geoscientists believe the volcanoes on a young planet covered much more extensively by water than today's served as oases of raw materials that allowed prebiotic matter to accumulate in sufficient quantities to assemble into more complex material and eventually into primitive life itself. Bada had already begun reanalyzing Miller's preserved samples and drawing conclusions about the role of volcanoes in sparking early life when he came across the previously unknown samples. In a 2008 analysis of samples left from Miller's more famous experiment, Bada's team had been able to detect many more amino acids than his former mentor had thanks to modern techniques unavailable to Miller.
Miller, who became a chemistry professor at UCSD in 1960, conducted the experiments while a faculty member at Columbia University. He had collected and catalogued samples from the hydrogen sulfide mix but never analyzed them. He only casually mentioned their existence late in his life and the importance of the samples was only realized shortly before his death in 2007, Bada said. It turned out, however, that his 1958 mix more closely resembled what geoscientists now consider early Earth conditions than did the gases in his more famous previous experiment.
"This really not only enhances our 2008 study but goes further to show the diversity of compounds that can be produced with a certain gas mixture," Bada said.
The Bada lab is gearing up to repeat Miller's classic experiments later this year. With modern equipment including a miniaturized microwave spark apparatus, experiments that took the elder researcher weeks to carry out could be completed in a day, Bada said.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of California - San Diego**, via EurekAlert!, a service of AAAS.

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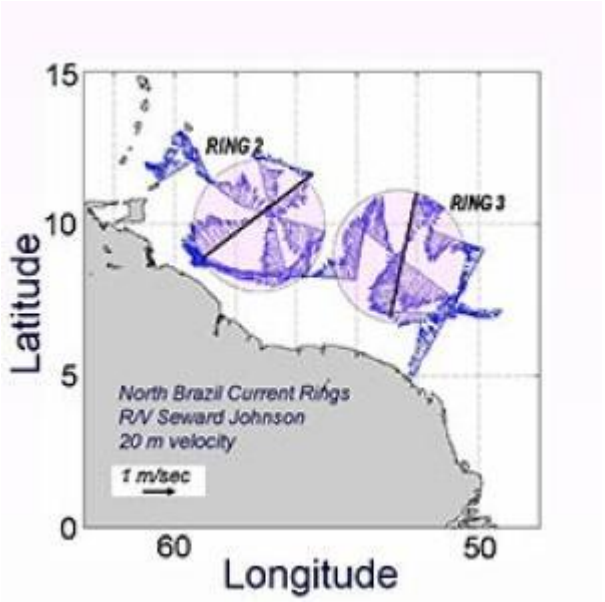
http://www.sciencedaily.com/releases/2011/03/110321161904.htm

Huge Ocean 'Frisbees' Spin Off Brazil's Coast



Huge ocean "Frisbees™" spin off Brazil's coast. University of Miami researchers have found that the rings are bigger and faster than previously thought. (Credit: Image courtesy of University of Miami Rosenstiel School of Marine & Atmospheric Science)

ScienceDaily (Mar. 21, 2011) — As the North Brazil Current (NBC) moves northward along the northeastern coast of Brazil, it draws water from the South Equatorial Current and the freshwater outflow from the Amazon River, providing a source for warm, nutrient-rich water. Just northwest of Brazil, part of the NBC banks a hard right and flows east along the equator. Occasionally, the turn is especially sharp and the current loops around, pinching off an independently- traveling parcel of warm water. This portion travels northwest with a clockwise rotation, moving through the ocean like a Frisbee™ travels through air.

These current rings have been known to exist for decades, but knowledge of their basic properties such as size, speed, depth, and rotation velocity has been limited. Drawing on current profiles from both shipboard and stationary instruments, University of Miami researchers Guilherme Castelão and Bill Johns describe the basic properties of ten rings sampled between 1998 and 2000. The authors find that the rings are best described as solid, clockwise-rotating parcels of water enclosed within a band of lower-speed water that tends to protect them from the surrounding environment.

Overall, this research has established that the NBC rings seem to be bigger, faster, and taller than previous observations suggested.

Story Source:

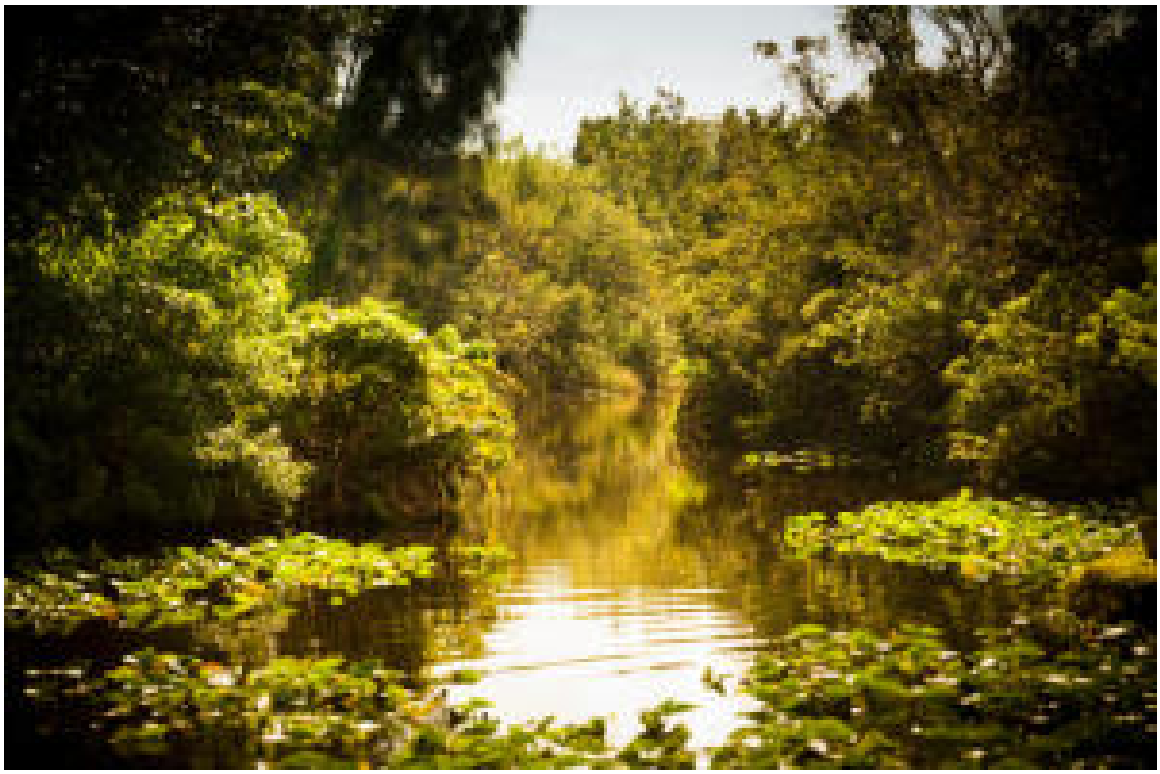
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of Miami Rosenstiel School of Marine & Atmospheric Science**.

Journal Reference:

1. G. P. Castelão, W. E. Johns. **Sea surface structure of North Brazil Current rings derived from shipboard and moored acoustic Doppler current profiler observations**. *Journal of Geophysical Research*, 2011; 116 (C1) DOI: 10.1029/2010JC006575

http://www.sciencedaily.com/releases/2011/03/110321162003.htm

Ancient Human Trash Heaps Gave Rise to Everglades Tree Islands, Research Suggests



Everglades National Park Florida USA. Garbage mounds left by prehistoric humans might have driven the formation of many of the Florida Everglades' tree islands, distinctive havens of exceptional ecological richness in the sprawling marsh that are today threatened by human development. (Credit: iStockphoto)

ScienceDaily (Mar. 21, 2011) — Garbage mounds left by prehistoric humans might have driven the formation of many of the Florida Everglades' tree islands, distinctive havens of exceptional ecological richness in the sprawling marsh that are today threatened by human development.

Tree islands are patches of relatively high and dry ground that dot the marshes of the Everglades. Typically a meter (3.3 feet) or so high, many of them are elevated enough to allow trees to grow. They provide a nesting site for alligators and a refuge for birds, panthers, and other wildlife.

Scientists have thought for many years that the so-called fixed tree islands (a larger type of tree island frequently found in the Everglades' main channel, Shark River Slough) developed on protrusions from the rocky layer of a mineral called carbonate that sits beneath the marsh. Now, new research indicates that the real trigger for island development might have been middens, or trash piles left behind from human settlements that date to about 5,000 years ago.

These middens, a mixture of bones, food discards, charcoal, and human artifacts (such as clay pots and shell tools), would have provided an elevated area, drier than the surrounding marsh, allowing trees and other vegetation to grow. Bones also leaked phosphorus, a nutrient for plants that is otherwise scarce in the Everglades.

"This goes to show that human disturbance in the environment doesn't always have a negative consequence," says Gail Chmura, a paleoecologist at McGill University in Montreal, Canada, and one of the authors of the study.

Chmura will be presenting her research on March 22, at the American Geophysical Union's Chapman Conference on Climates, Past Landscapes, and Civilizations.

In a previous scientific investigation of tree islands, Margo Schwadron, an archeologist with the National Park Service, cut through the elevated bedrock at the base of two islands and discovered that it was actually a so-called "perched carbonate layer," because there was more soil and a midden below. Later, a team including

Chmura's graduate student Maria-Theresia Graf performed additional excavations in South Florida and found more of the perched carbonate layers.
Chemical analysis of samples of these curious perched layers revealed that they are made up partially of carbonates that had dissolved from the bedrock below, Chmura says. The layer also contains phosphorus from dissolved bones, she adds. Her team concluded that trees are key to the formation of this layer: During South Florida's dry season, their roots draw in large quantities of ground water but allow the phosphates and carbonates dissolved in it to seep out and coalesce into the stone-like layer.
The perched carbonate plays a key role in letting tree islands rebound after fires: because it does not burn, it protects the underlying soil, and it maintains the islands' elevation, allowing vegetation to regrow after the fire. Humans are now threatening the existence of tree islands, by cutting down trees (whose roots keep the perched layer in place) and artificially maintaining high water levels year-round in some water control systems, which could cause the layer to dissolve.
Chmura's team now wants to explore exactly when trees started growing on the tree islands.

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

http://www.sciencedaily.com/releases/2011/03/110321134627.htm

Simulating Tomorrow's Accelerators at Near the Speed of Light

Like a speedboat leaving a wake that a surfer can ride, a laser pulse in a laser-plasma wakefield accelerator creates a wake in the plasma that an electron beam "surfs" to high energy. The ridges at bottom right are the laser pulse, which drives the wake as it speeds through the plasma. Colors in the wake represent intense electric fields: the decelerating fields (orange) and accelerating fields (blue) drive the electrons (white) to high energy. (Credit: Image courtesy of DOE/Lawrence Berkeley National Laboratory; Original boat-surfing photo by Sean C. Fulton)

ScienceDaily (Mar. 22, 2011) — As conventional accelerators like CERN's Large Hadron Collider grow ever more vast and expensive, the best hope for the high-energy machines of the future may lie in "tabletop" accelerators like BELLA (the Berkeley Lab Laser Accelerator), now being built by the LOASIS program at the U.S. Department of Energy's Lawrence Berkeley National Laboratory (Berkeley Lab). BELLA, a laser-plasma wakefield accelerator, is remarkably compact. In just one meter a single BELLA stage will accelerate an electron beam to 10 billion electron volts, a fifth the energy achieved by the two-mile long linear accelerator at the SLAC National Accelerator Laboratory.

But realizing the promise of laser-plasma accelerators crucially depends on being able to simulate their operation in three-dimensional detail. Until now such simulations have challenged or exceeded even the capabilities of supercomputers.

A team of researchers led by Jean-Luc Vay of Berkeley Lab's Accelerator and Fusion Research Division (AFRD) has borrowed a page from Einstein to perfect a revolutionary new method for calculating what happens when a laser pulse plows through a plasma in an accelerator like BELLA. Using their "boosted-frame" method, Vay's team has achieved full 3-D simulations of a BELLA stage in just a few hours of supercomputer time, calculations that would have been beyond the state of the art just two years ago.

Not only are the recent BELLA calculations tens of thousands of times faster than conventional methods, they overcome problems that plagued previous attempts to achieve the full capacity of the boosted-frame method, such as violent numerical instabilities. Vay and his colleagues, Cameron Geddes of AFRD, Estelle Cormier-Michel of the Tech-X Corporation in Denver, and David Grote of Lawrence Livermore National Laboratory, publish their latest findings in the March, 2011 issue of the journal *Physics of Plasma Letters*.

Space, time, and complexity

The boosted-frame method, first proposed by Vay in 2007, exploits Einstein's Special Theory of Relativity to overcome difficulties posed by the huge range of space and time scales in many accelerator systems. Vast discrepancies of scale are what made simulating these systems too costly.

"Most researchers assumed that since the laws of physics are invariable, the huge complexity of these systems must also be invariable," says Vay. "But what are the appropriate units of complexity? It turns out to depend on how you make the measurements."

Laser-plasma wakefield accelerators are particularly challenging: they send a very short laser pulse through a plasma measuring a few centimeters or more, many orders of magnitude longer than the pulse itself (or the even-shorter wavelength of its light). In its wake, like a speedboat on water, the laser pulse creates waves in the plasma. These alternating waves of positively and negatively charged particles set up intense electric

fields. Bunches of free electrons, shorter than the laser pulse, "surf" the waves and are accelerated to high energies.

"The most common way to model a laser-plasma wakefield accelerator in a computer is by representing the electromagnetic fields as values on a grid, and the plasma as particles that interact with the fields," explains Geddes, a member of the BELLA science staff who has long worked on laser-plasma acceleration. "Since you have to resolve the finest structures -- the laser wavelength, the electron bunch -- over the relatively enormous length of the plasma, you need a grid with hundreds of millions of cells."

The laser period must also be resolved in time, and calculated over millions of time steps. As a result, while much of the important physics of BELLA is three-dimensional, direct 3-D simulation was initially impractical. Just a one-dimensional simulation of BELLA required 5,000 hours of supercomputer processor time at Berkeley Lab's National Energy Research Scientific Computing Center (NERSC).

Choosing the right frame

The key to reducing complexity and cost lies in choosing the right point of view, or "reference frame." When Albert Einstein was 16 years old he imagined riding along in a frame moving with a beam of light -- a thought experiment that, 10 years later, led to his Special Theory of Relativity, which establishes that there is no privileged reference frame. Observers moving at different velocities may experience space and time differently and even see things happening in a different order, but calculations from any point of view can recover the same physical result.

Among the consequences are that the speed of light in a vacuum is always the same; compared to a stationary observer's experience, time moves more slowly while space contracts for an observer traveling near light speed. These different points of view are called Lorentz frames, and changing one for another is called a Lorentz transformation. The "boosted frame" of the laser pulse is the key to enabling calculations of laser-plasma wakefield accelerators that would otherwise be inaccessible.

A laser pulse pushing through a tenuous plasma moves only a little slower than light through a vacuum. An observer in the stationary laboratory frame sees it as a rapid oscillation of electromagnetic fields moving through a very long plasma, whose simulation requires high resolution and many time steps. But for an observer moving with the pulse, time slows, and the frequency of the oscillations is greatly reduced; meanwhile space contracts, and the plasma becomes much shorter. Thus relatively few time steps are needed to model the interaction between the laser pulse, the plasma waves formed in its wake, and the bunches of electrons riding the wakefield through the plasma. Fewer steps mean less computer time.

Eliminating instability

Early attempts to apply the boosted-frame method to laser-plasma wakefield simulations encountered numerical instabilities that limited how much the calculation frame could be boosted. Calculations could still be speeded up tens or even hundreds of times, but the full promise of the method could not be realized.

Vay's team showed that using a particular boosted frame, that of the wakefield itself -- in which the laser pulse is almost stationary -- realizes near-optimal speedup of the calculation. And it fundamentally modifies the appearance of the laser in the plasma. In the laboratory frame the observer sees many oscillations of the electromagnetic field in the laser pulse; in the frame of the wake, the observer sees just a few at a time.

Not only is speedup possible because of the coarser resolution, but at the same time numerical instabilities due to short wavelengths can be suppressed without affecting the laser pulse. Combined with special techniques for interpreting the data between frames, this allows the full potential of the boosted-frame principle to be reached.

"We produced the first full multidimensional simulation of the 10 billion-electron-volt design for BELLA," says Vay. "We even ran simulations all the way up to a trillion electron volts, which establishes our ability to model the behavior of laser-plasma wakefield accelerator stages at varying energies. With this calculation we achieved the theoretical maximum speedup of the boosted-frame method for such systems -- a million times faster than similar calculations in the laboratory frame."

Simulations will still be challenging, especially those needed to tailor applications of high-energy laser-plasma wakefield accelerators to such uses as free-electron lasers for materials and biological sciences, or for homeland security or other research. But the speedup achieves what might otherwise have been virtually impossible: it puts the essential high-resolution simulations within reach of new supercomputers.

This work was supported by the U.S. Department of Energy's Office of Science, including calculations with the WARP beam-simulation code and other applications at the National Energy Research Scientific Computing Center (NERSC).

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:

1. J.-L. Vay, C. G. R. Geddes, E. Cormier-Michel, D. P. Grote. **Effects of hyperbolic rotation in Minkowski space on the modeling of plasma accelerators in a Lorentz boosted frame**. *Physics of Plasmas*, 2011; 18 (3): 030701 DOI: 10.1063/1.3559483

http://www.sciencedaily.com/releases/2011/03/110322114831.htm

Dawn Opens Its Eyes, Checks Its Instruments

NASA's Dawn spacecraft, illustrated in this artist's concept, is propelled by ion engines. (Credit: NASA/JPL)

ScienceDaily (Mar. 22, 2011) — After a hibernation of about six months, the framing cameras on board NASA's Dawn spacecraft have again ventured a look into the stars. The spacecraft also powered up its visible and infrared mapping spectrometer, which investigates surface mineralogy, and the gamma ray and neutron detector, which detects elemental composition. The reactivation prepares the instruments for the May approach and July arrival at Vesta, Dawn's first port of call in the asteroid belt.

"Last week, we gently 'woke up' Dawn's three science instruments, which typically spend most of their time sleeping during the three-and-a-half-year journey to Vesta," said Robert Mase, Dawn project manager at NASA's Jet Propulsion Laboratory, Pasadena, Calif. "This activity confirms that Dawn is on track for the first close examination of one of the last unexplored worlds of the inner solar system."

The framing camera activities were led by scientists from the Max Planck Institute for Solar System Research in Katlenburg-Lindau, Germany. "The camera system is working flawlessly. The dry run was a complete success," said Andreas Nathues, lead investigator for the framing camera, based at the Institute.

The international team of Dawn scientists and engineers in Germany and the United States spent three days interacting with the camera system, confirming the excellent health of the mechanical and electrical components and updating the software.

In the months to come, the camera system will provide images needed to navigate the spacecraft to its rendezvous with Vesta, and will begin to image the asteroid's surface. These early images on approach will be the start of a campaign to systematically map Vesta's surface in detail and will provide tantalizing clues as to its mineralogical composition. In addition, the framing cameras will search for moons in Vesta's vicinity and look for evidence of past volcanic activity.

The Dawn mission to Vesta and Ceres is managed by the Jet Propulsion Laboratory, a division of the California Institute of Technology in Pasadena, for NASA's Science Mission Directorate, Washington. The

Dawn mission is part of the Discovery Program managed by NASA's Marshall Space Flight Center in Huntsville, Ala. UCLA is responsible for overall Dawn mission science.
The framing cameras have been developed and built under the leadership of the Max Planck Institute for Solar System Research, Katlenburg-Lindau, Germany, with significant contributions by DLR German Aerospace Center, Institute of Planetary Research, Berlin, and in coordination with the Institute of Computer and Communication Network Engineering, Braunschweig. The framing camera project is funded by the Max Planck Society, DLR, and NASA. The visible and infrared mapping spectrometer was provided by the Italian Space Agency and is operated by Italy's National Institute for Astrophysics in collaboration with Galileo Avionica, where it was built. The gamma ray and neutron detector was built by Los Alamos National Laboratory and is operated by the Planetary Science Institute, Tucson, Ariz.

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/2011/03/110322115810.htm

Saving One of the World's Most Endangered Birds

The entire population of the Tuamotu Kingfisher -- less than 125 -- lives on one tiny island in the south Pacific, and without serious intervention soon, they will cease to exist. (Credit: Kesler/University of Missouri)

ScienceDaily (Mar. 22, 2011) — The Tuamotu Kingfisher is a multicolored, tropical bird with bright blue feathers, a dusty orange head, and a bright green back. The entire population of these birds -- less than 125 -- lives on one tiny island in the south Pacific, and without serious intervention, they will no longer exist. One University of Missouri researcher is trying to stop the birds' extinction by working with farmers and residents on the island inhabited by the kingfishers.

"If we lose these birds, we lose 50,000 years of uniqueness and evolution," said Dylan Kesler, assistant professor in fisheries and wildlife at the University of Missouri's School of Natural Resources in the College of Agriculture, Food and Natural Resources. "Because it has lived in isolation for a very long time, it's unlike any other bird. There is no other bird like this on the planet."

In new studies published in the journal *The Auk* (published by the American Ornithologists Union) and the *Journal of Wildlife Management*, Kesler and his team of researchers have uncovered important information to help ensure the birds' survival and a unique way to attach radio transmitters to the birds to track them.

To survive, the kingfishers need several specific habitat characteristics:

- Hunting Perches about 5 feet off the ground -- The birds hunt by "pouncing." They watch their prey and then fall on them from hunting perches about 5 feet high. Without the perches in broadleaf trees at the appropriate height, the birds have no way to hunt.
- Exposed ground -- the birds' food consists mainly of lizards, which are easier to spot where the ground is clear of vegetation. When coconut farmers conduct intermediate burns on their land --

which are hot enough to kill brush, but do not lead to widespread fires or kill the lizards -- it exposes more ground and the birds can see the lizards.

- Dead trees for nesting -- the birds create nests by flying into dead trees and hollowing cavities. Live trees are too hard and many farmers cut down their dead coconut trees. By encouraging farmers to leave some dead trees, the birds will continue to be able to build nests.
- Lessoning the impact of predators -- cats and rats, which were introduced to the island by humans, now hunt the Tuamotu Kingfisher. By wrapping metal bands around the trees, the predators are less likely to get into the nests, but Kesler is still searching for other solutions that might alleviate the pressure on the birds.

In a separate study, Kesler also developed a "weak-link" radio harness for the birds to wear. In previous studies with different birds, scientists have reported unintentional harm to the birds after attaching radio transmitters. That harm included scratching the birds, making the birds act peculiarly and introducing infections. Using this new harness, Kesler was able to track the birds during the study, and the harness was shed within two months.
"Unfortunately, even with all our work to date, the population is still crashing," Kesler said. "We're seeing some turnover, but each year when we return, there are more empty territories and the population decreases. At this rate, these birds will be gone within our lifetime."

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

http://www.sciencedaily.com/releases/2011/03/110321134716.htm

How the Lily Blooms: Ruffling at the Edge of Each Petal Drives the Delicate Flower to Open

Petal almost ready for blooming. Mahadevan and Liang created an mathematical model to show how peripheral growth causes the developing petals to ruffle at the edges and curve outward, leading to blooming. (Credit: Courtesy of L. Mahadevan, Harvard School of Engineering and Applied Sciences)

ScienceDaily (Mar. 22, 2011) — The "lily white" has inspired centuries' worth of rich poetry and art, but when it comes to the science of how and why those delicately curved petals burst from the bud, surprisingly little is known.

Now, however, mathematics has revealed that differential growth and ruffling at the edges of each petal -- not in the midrib, as commonly suggested -- provide the driving force behind the lily's bloom.

The research, conducted at Harvard's School of Engineering and Applied Sciences (SEAS), contradicts earlier theories regarding growth within the flower bud. The petals, in fact, behave like leaves.

Published online this week in the journal *Proceedings of the National Academy of Sciences*, the findings characterize the blooming process using mathematical theory, observation, and experiment.

"That differences in planar growth strains can lead to shape changes has been known for some time," says principal investigator L. Mahadevan, the Lola England de Valpine Professor of Applied Mathematics at SEAS. "But showing that it is at work and dominant in lily blooming is new, as our measurements and simple theory show."

"What is most surprising is that a subject that is so rich in metaphor -- the blooming of a flower -- had been studied so little from a quantitative perspective."

Mahadevan collaborated with Haiyi Liang, formerly a postdoctoral fellow at SEAS and now a professor at the University of Science and Technology of China in Hefei.

Together, they studied the Asiatic lily *Lilium casablanca*, the bud of which comprises three inner petals wrapped in three outer sepals.

A stiff midrib runs along the center of each petal and sepal, protecting the structure of the developing flower bud. The edges of the sepals also rest in grooves along the midribs of the petals, forming a locking mechanism that holds the bud closed until the growth inside reaches a critical point.

It was previously suggested that growth in the midribs might provide enough internal stress for the petals to burst out of their casing. Another plausible theory held that if the internal (adaxial) face of each petal and sepal grew faster than the external (abaxial) face, the flower would eventually be forced to bend outward. In some plants, these mechanisms do drive the blooming process.

Liang and Mahadevan's new research shows that in the lily, however, midrib growth and differential adaxial/abaxial growth play only minor roles. Rapid growth and wrinkling at the periphery of the petals actually create the stress within the bud that forces it to burst open.

The researchers used observation and experimentation to measure growth in various parts of the petals and to determine which types of growth are necessary for blooming. They then characterized the process mathematically in order to quantify, synthesize, and generalize their observations beyond the specific instance.

The findings contradict common assumptions about the lily, but they do seem to vindicate one unlikely theorist: German literary master Johann Wolfgang von Goethe.
In a 1790 essay, "Metamorphosis of Plants," Goethe proposed that petals and leaves could be homologous, meaning that they are both derived from one ancestral form.
"In a sense," says Mahadevan, "we have quantified one aspect of the similarity by showing that in addition to being laminae (like blades), the morphologies of petals and leaves are often determined by similar principles."
"In particular, leaves have rippled edges due to gradients in growth in the plane that lead to the edge growing more than the middle, a phenomenon that Liang and I demonstrated in 2009," he adds. "Here, we build on and generalize these results to show that lilies bloom using a mechanism that is similar to leaf growth, except that the petals are curved objects."
In addition to his appointment at SEAS, Mahadevan is a Professor of Organismic and Evolutionary Biology at Harvard, a Core Member of the Wyss Institute for Biologically Inspired Engineering at Harvard, an affiliate of the Harvard Department of Physics, and a member of the Kavli Institute for Bionano Science and Technology.
His previous research, often inspired by beauty in nature, has investigated questions such as how snakes slither and how the Venus fly trap snaps its jaws.
The question of how the lily blooms, Mahadevan says, "is just one more small instance of being inspired by and curious about the natural world around us, a subject that fascinates us all, child and adult alike."
The research also has immediate practical applications in materials science involving thin films and elastic sheets, and it may affect the development of devices such as sensors and actuators that mimic the mechanism of blooming.
The work was partially funded by the National Science Foundation (NSF)-funded Materials and Research Science and Engineering Center at Harvard and the Defense Advanced Research Projects Agency (DARPA).

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.

Journal Reference:

1. Haiyi Liang and L. Mahadevan. **Growth, geometry, and mechanics of a blooming lily**. *PNAS*, March 21, 2011 DOI: 10.1073/pnas.1007808108

http://www.sciencedaily.com/releases/2011/03/110321161918.htm

Fewer Bats Carry Rabies Than Thought

Brandon Klug holds a little brown bat (Myotis lucifugus) captured from an attic in Montana. Little brown bats often inhabit attics of buildings, both used and abandoned, in the summers because the warmth makes it easier to raise young. (Credit: Erin Baerwald, University of Calgary)

ScienceDaily (Jan. 31, 2011) — Bats tend to have a bad reputation. They sleep all day, party at night, and are commonly thought to be riddled with rabies. A study by University of Calgary researchers has confirmed that bats are not as disease-ridden as the stigma suggests.

"The notion that bats have high rates of rabies is not true," says Brandon Klug, a graduate student at the University of Calgary and the lead author of a paper published in the *Journal of Wildlife Diseases*.

"Those of us that work with bats have always known the rates are low; and now we have evidence that bats aren't disease-ridden vermin their reputation would have you believe."

Previous studies have suggested that typically about 10 per cent of bats taken by the public to be tested have the disease and prevalence varies greatly, depending on the species and how often that species is around people. But University of Calgary research says the number is closer to one per cent regardless of species or where the bats roost.

Researchers compared bats turned in by the general public and those randomly sampled from their natural environment. In the field, they looked for the disease in carcasses of migratory tree-roosting hoary bats (*Lasiurus cinereus*) and silver-haired bats (*Lasionycteris noctivagans*) killed by wind turbines. These species are among bat species with the highest reported prevalence of rabies in North America. At the same time they compared these bats with rabies prevalence from literature contained in public health records in North America.

"This study is significant because it confirms that rabies rates for bats has been over-estimated. It's also the first time such a rigorous literature review has been completed on this topic," says co-author Dr. Robert Barclay, biological science professor and head of the Department of Biological Sciences at the University of Calgary.

University of Calgary researchers sent 217 carcasses to the Centers of Disease Control and Prevention in the U.S for testing. They also reviewed the literature on reported rabies in multiple bat species in North America covering the past 56 years, which included 65,096 bats.
Bats, along with other species including foxes, skunks and raccoons, are considered reservoirs for the disease. Rabies is passed from bat to bat at a rate that keeps the virus in the population, but rarely fast enough to eradicate the bat population or slow enough to result in the demise of the virus.
"Since the background rabies rate in bats is low, less than one percent, people should focus more on the ecosystem services they provide without worrying that every other bat has rabies. This is especially important right now because bats are facing some heavy threats, like wind turbines and white nose syndrome," says Klug.
"With that said, healthy bats normally don't come in contact with people, so those that do are more likely to be sick, so we're not encouraging people to go out and handle them."

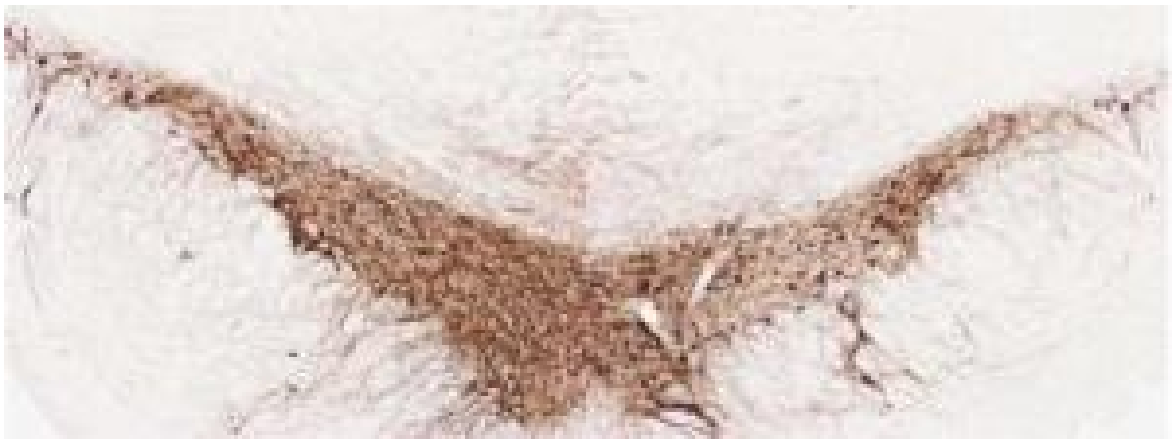
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of Calgary**, via EurekAlert!, a service of AAAS.

Journal Reference:

1. Klug, Brandon J., Turmelle, Amy S., Ellison, James A., Baerwald, Erin F., Barclay, Robert M. R. **Rabies Prevalence in Migratory Tree-Bats in Alberta and the Influence of Roosting Ecology and Sampling Method on Reported Prevalence of Rabies in Bats**. *J Wildl Dis*, 2011 47: 64-77 [link]

http://www.sciencedaily.com/releases/2011/01/110131133323.htm

New Model for Studying Parkinson's: Swiss Researchers Develop New, Working Mammalian Model to Combat Genetic Causes of the Disease



This is a cervical slice showing the healthy left-hand side of the brain and the damaged, Parkinson's disease side with lesions provoked by the LKKR2 gene mutation. (Credit: EPFL)

ScienceDaily (Mar. 22, 2011) — Evidence is steadily mounting that genetic factors play an important role in many cases of Parkinson's disease (PD). In a study published February 2, 2011, online in the *Journal of Neuroscience*, researchers from the Ecole Polytechnique Fédérale de Lausanne (EPFL) in Switzerland report a new mammalian model for studying a specific gene mutation commonly found in PD sufferers, opening the door to new drugs to fight the malady.

"This is a great step forward toward a more comprehensive understanding of how the disease works, and how it can be diagnosed and treated," explains neuroscientist and EPFL President Patrick Aebischer, lead author of the study.

PD is a common neurodegenerative disease that greatly reduces quality of life and costs the United States around 23 billion dollars a year. Until now, researchers have encountered difficulty in reproducing PD pathology in animals because of an incomplete understanding of the disease.

Recently, a mutation of the gene coding for LRRK2, a large enzyme in the brain, has emerged as the most prevalent genetic cause of PD (genetics are implicated in about 10 percent of all PD cases). When the enzyme is mutated, it becomes hyperactive, causing the death of vulnerable neurons and leading to a reduction in levels of the brain neurotransmistter dopamine. This decrease in dopamine eventually triggers the symptoms characteristic of Parkinson's, such as tremors, instability, impaired movement, and later stage dementia. Now, with funding from the Michael J. Fox Foundation for Parkinson's Research, Aebischer and his team in the Neurodegenerative Studies Laboratory at EPFL, have successfully introduced mutant LRRK2 enzyme into one hemisphere of a rat brain, resulting in the same PD manifestations that occur in humans in one side of the rodent's body. To do this, the researchers spent two years producing and optimizing a viral vector to deliver mutated, LRRK2 coding DNA into the rat brain. LRRK2 is a large and complicated enzyme and designing a vector capable of transporting its extremely long genetic code was no small feat.

The new animal model developed by EPFL is sure to benefit future Parkinson's research. The fact that LRRK2 is an enzyme -- a catalyzing protein involved in chemical reactions -- makes it drug accessible and therefore of specific interest to researchers looking for neuroprotective strategies, or pharmaceutical treatments that halt or slow disease progression by protecting vulnerable neurons. Armed with the LRRK2 model, new pharmaceuticals that inhibit the hyper-activity of the enzyme could one day prevent the destructive chain of events that leads to neurodegeneration and devastation in many with PD.

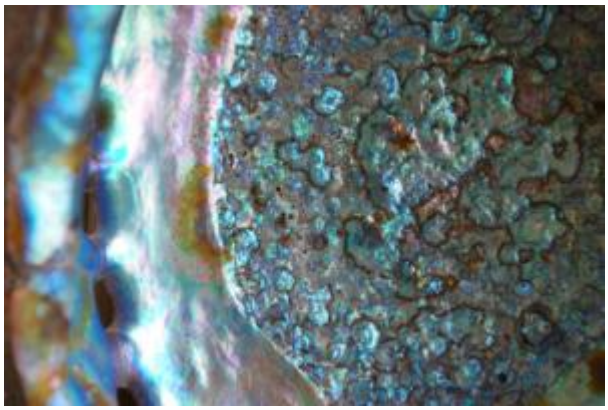
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Ecole Polytechnique Fédérale de Lausanne**, via EurekAlert!, a service of AAAS.

Journal Reference:

1. J. Dusonchet, O. Kochubey, K. Stafa, S. M. Young, R. Zufferey, D. J. Moore, B. L. Schneider, P. Aebischer. **A Rat Model of Progressive Nigral Neurodegeneration Induced by the Parkinson's Disease-Associated G2019S Mutation in LRRK2**. *Journal of Neuroscience*, 2011; 31 (3): 907 DOI: 10.1523/JNEUROSCI.5092-10.2011

http://www.sciencedaily.com/releases/2011/02/110201172609.htm

Only the Weak Survive? Self-Healing Materials Strengthened by Adding More 'Give'



Abalone shell close-up. An amalgamation of microscopic ceramic plates and a small percentage of soft protein, the abalone shell absorbs a blow by stretching and sliding rather than shattering. (Credit: iStockphoto/Bridget Lazenby)

ScienceDaily (Mar. 22, 2011) — A Pitt and Carnegie Mellon team developed a new model of how self-repairing materials function and show that materials with a certain number of easily breakable bonds can absorb more stress, a natural trick found in the resilient abalone shell, according to a report in *Langmuir*.

Conventional rules of survival tend to favor the strongest, but University of Pittsburgh-based researchers recently found that in the emerging world of self-healing materials, it is the somewhat frail that survive.

The team presents in the journal *Langmuir* a new model laying out the inner workings of self-healing materials made of nanoscale gel particles that can regenerate after taking damage and are being pursued as a coating or composite material. Moreover, the researchers discovered that an ideal amount of weak bonds actually make for an overall stronger material that can withstand more stress.

Although self-healing nanogel materials have already been realized in the lab, the exact mechanical nature and ideal structure had remained unknown, explained Anna Balazs, corresponding author and Distinguished Professor of Chemical Engineering in Pitt's Swanson School of Engineering. The team's findings not only reveal how self-healing nanogel materials work, but also provide a blueprint for creating more resilient designs, she said. Balazs worked with lead author and Pitt postdoctoral researcher Isaac Salib; Chet Gnegy, a Pitt chemical and petroleum engineering sophomore; German Kolmakov, a postdoctoral researcher in Balazs' lab; and Krzysztof Matyjaszewski, a chemistry professor at Carnegie Mellon University with an adjunct appointment in Pitt's Department of Chemical and Petroleum Engineering.

The team worked from a computational model Gnegy, Kolmakov, and Salib created based on a self-healing material Matyjaszewski developed known as nanogel, a composition of spongy, microscopic polymer particles linked to one another by several tentacle-like bonds. The nanogel particles consist of stable bonds -- which provide overall strength -- and labile bonds, highly reactive bonds that can break and easily reform, that act as shock absorbers.

The computer model allowed the researchers to test the performance of various bond arrangements. The polymers were first laid out in an arrangement similar to that in the nanogel, with the tentacles linked end-to-end by a single strong bond. Simulated stress tests showed, however, that though these bonds could recover from short-lived stress, they could not withstand drawn out tension such as stretching or pulling. Instead, the team found that when particles were joined by several parallel bonds, the nanogel could absorb more stress and still self-repair.

The team then sought the most effective concentration of parallel labile bonds, Balazs said. According to the computational model, even a small number of labile bonds greatly increased resilience. For instance, a sample in which only 30 percent of the bonds were labile -- with parallel labile bonds placed in groups of four -- could withstand pressure up to 200 percent greater than what could fracture a sample comprised only of stable bonds. A film shows that as this sample is stretched, the labile bonds (red) rearrange themselves to hold the material together.

On the other hand, too many labile linkages were so collectively strong that the self-healing ability was cancelled out and the nanogel became brittle, the researchers report.
The Pitt model is corroborated by nature, which engineered the same principle into the famously tough abalone shell, Balazs said. An amalgamation of microscopic ceramic plates and a small percentage of soft protein, the abalone shell absorbs a blow by stretching and sliding rather than shattering.
"What we found is that if a material can easily break and reform, the overall strength is much better," she said. "In short, a little bit of weakness gives a material better mechanical properties. Nature knows this trick."

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

Journal Reference:

1. Isaac G. Salib, German V. Kolmakov, Chet N. Gnegy, Krzysztof Matyjaszewski, Anna C. Balazs. **Role of Parallel Reformable Bonds in the Self-Healing of Cross-Linked Nanogel Particles**. *Langmuir*, 2011; : 110224111613065 DOI: 10.1021/la104609t

http://www.sciencedaily.com/releases/2011/03/110322151306.htm

In the Race of Life, Better an Adaptable Tortoise Than a Fit Hare

Redfoot tortoise (Geochelonia carbonaria) and a Dutch rabbit. When it comes to survival of the fittest, it's sometimes better to be an adaptable tortoise than a fitness-oriented hare, an evolutionary biologist says. (Credit: iStockphoto/Mark Tooker)

ScienceDaily (Mar. 22, 2011) — When it comes to survival of the fittest, it's sometimes better to be an adaptable tortoise than a fitness-oriented hare, a Michigan State University evolutionary biologist says.

In the journal *Science*, Richard Lenski, MSU Hannah Distinguished Professor of Microbiology and Molecular Genetics, and colleagues show that more adaptable bacteria oriented toward long-term improvement prevailed over competitors that held a short-term advantage.

The discovery that the less-fit organisms overtook their in-shape counterparts surprised the researchers at first. But it turns out to work something like a game of chess.

"In games it makes sense to sacrifice some pieces for an eventual winning move," said Lenski, co-principal investigator of BEACON, MSU's National Science Foundation-funded Science and Technology Center. "The eventual winners were able to overcome their short-term disadvantage over the course of several evolutionary moves by producing more beneficial mutations."

Lenski is recognized as a leading evolutionary experimentalist, recording evolutionary change over 52,000 generations of bacteria grown during nearly 25 years. He and his team recently revived a frozen population of E. coli and compared the fitness and ultimate fates of four clones representing two genetically distinct lineages. One lineage eventually took over the population even though it had significantly lower competitive fitness than the other lineage that later went extinct.

By replaying evolution over and over with the clones, the researchers showed that the eventual winners likely prevailed because they had greater potential for further adaptation.

"In essence, the eventual loser lineage seems to have made a mutational move that gave it a short-term fitness advantage but closed off certain routes for later improvement," Lenski said. "And the dead-end strategy allowed the eventual winners to catch up and eventually surpass the eventual losers."

So, yes, sometimes the tortoise really does beat the hare.

Lenski's collaborators include co-author Robert Woods, an MSU graduate who worked in Lenski's laboratory and is now a physician scientist at the University of Michigan; Jeffrey Barrick, another Lenski lab researcher now on the faculty at the University of Texas; Tim Cooper from the University of Houston; MSU undergraduate student Mark Kauth; and University of Houston student Utpala Shrestha.

While Darwin's theory of natural selection has been confirmed by a great deal of other research, it has never before been observed directly for so many generations and in such detail as Lenski's long-term experiment has afforded. Lenski's research is supported by the National Science Foundation, the Defense Advanced Research Projects Agency and by MSU AgBioResearch.

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

Journal Reference:

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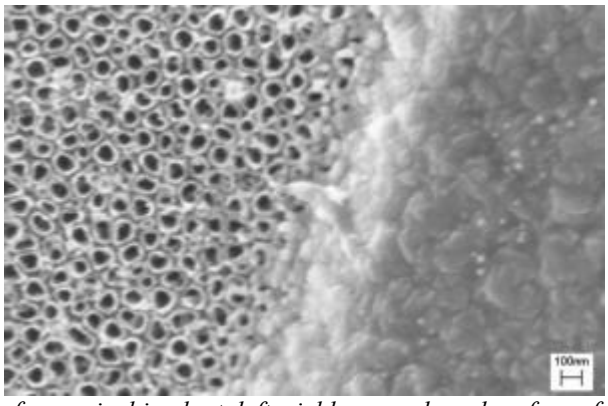
http://www.sciencedaily.com/releases/2011/03/110322105304.htm

Nanomodified Surfaces Seal Leg Implants Against Infection



Nanotubular surfaces Anodizing the titanium surface of a surgical implant, left, yields a roughened surface of nanotubes, which skin cells colonize more quickly. (Credit: Webster Lab/Brown University)

ScienceDaily (Mar. 22, 2011) — In recent years, researchers have worked to develop more flexible, functional prosthetics for soldiers returning home from battlefields in Afghanistan or Iraq with missing arms or legs. But even new prosthetics have trouble keeping bacteria from entering the body through the space where the device has been implanted.

"You need to close (the area) where the bacteria would enter the body, and that's where the skin is," said Thomas Webster, associate professor of engineering and orthopaedics at Brown University.

Webster and a team of researchers at Brown may have come across the right formula to deter bacterial migrants. The group reports two ways in which it modified the surface of titanium leg implants to promote skin cell growth, thereby creating a natural skin layer and sealing the gap where the device has been implanted into the body. The researchers also created a molecular chain to sprinkle skin-growing proteins on the implant to hasten skin growth.

The findings are published in the *Journal of Biomedical Materials Research A.*

The researchers, including Melanie Zile, a Boston University student who worked in Webster's lab as part of Brown's Undergraduate Teaching and Research Awards program, and Sabrina Puckett, who earned her engineering doctorate last May, created two different surfaces at the nanoscale, dimensions less than a billionth of a meter.

In the first approach, the scientists fired an electron beam of titanium coating at the abutment (the piece of the implant that is inserted into the bone), creating a landscape of 20-nanometer mounds. Those mounds imitate the contours of natural skin and trick skin cells into colonizing the surface and growing additional keratinocytes, or skin cells.

Webster knew such a surface, roughened at the nanoscale, worked for regrowing bone cells and cartilage cells, but he was unsure whether it would be successful at growing skin cells. This may be the first time that a nanosurface created this way on titanium has been shown to attract skin cells.

The second approach, called anodization, involved dipping the abutment into hydrofluoric acid and giving it a jolt of electric current. This causes the titanium atoms on the abutment's surface to scurry about and regather as hollow, tubular structures rising perpendicularly from the abutment's surface. As with the nanomounds, skin cells quickly colonize the nanotubular surface.

In laboratory (in vitro) tests, the researchers report nearly a doubling of skin cell density on the implant surface; within five days, the keratinocyte density reached the point at which an impermeable skin layer bridging the abutment and the body had been created.

"You definitely have a complete layer of skin," Webster said. "There's no more gap for the bacteria to go through."

To further promote skin cell growth around the implant, Webster's team looked to FGF-2, a protein secreted by the skin to help other skin cells grow. Simply slathering the abutment with the proteins doesn't work, as FGF-2 loses its effect when absorbed by the titanium. So the researchers came up with a synthetic molecular chain to bind FGF-2 to the titanium surface, while maintaining the protein's skin-cell growing ability. Not surprisingly, in vitro tests showed the greatest density of skin cells on abutment surfaces using the

nanomodified surfaces and laced with FGF-2. Moreover, the nanomodified surfaces create more surface area for FGF-2 proteins than would be available on traditional implants.
The next step is to perform in vivo studies; if they are successful, human trials could begin, although Webster said that could be years away.
The U.S. Department of Veterans Affairs and the U.S. National Science Foundation funded the research.

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

Journal Reference:

1. Melanie A. Zile, Sabrina Puckett, Thomas J. Webster. **Nanostructured titanium promotes keratinocyte density**. *Journal of Biomedical Materials Research Part A*, 2011; 97A (1): 59 DOI: 10.1002/jbm.a.33028

http://www.sciencedaily.com/releases/2011/03/110322151249.htm

The Mekong: Record of the Vietnam War

Canoes. (Credit: © IRD / Alain Pierret)

ScienceDaily (Mar. 22, 2011) — During the second half of the 20th Century, South-East Asia was the arena of a series of armed conflicts, direct consequences of the Second World War, decolonization and the Cold War, followed by political instability which continued up to the 1990s. The region's history has left its scars: extensive forests erased from the map by bombing, populations displaced or forced to emigrate, entire areas abandoned although vegetation is steadily taking over again.

Research scientists from the IRD and its partners[1] recently showed the discharge rate of the Mekong has oscillated in close correlation with the major events that had taken place. Runoff increased by over 50% in southern Laos between 1972 and 1975, at the height of the Vietnam War. Conversely, the north of the country saw it decrease by 30% between 1995 and 2004, following people's exodus from the area to escape from the communist forces' advance. Only the extensive changes in land-use and vegetation pattern can explain such variations in discharge of the Mekong.

Twenty years of war in South-East Asia, from 1955 to 1975, followed by political instability up to the end of the 1980s have strongly marked the environment. Analysis of Mekong Commission[2] hydro-meteorological data showed IRD researchers and their partners[1] that the changes in the great river's discharge rate were correlated with the dramatic events which marked the whole region's history.

To characterize the effects of these events on the runoff which feeds the river system, the researchers focused on two war zones: one in southern Laos, subjected to heavy bombing, the other in the North of the country, the arena for intensive land-based military operations.

Destruction of forest cover to expose the enemy

Between 1965 and 1975 South-East Asia was the theatre of the heaviest bombing campaigns in human history. In the first area studied, as many bombs were released as in the whole world over during the Second World War. In the face of elusive guerrilla forces, bombing systematically destroyed the vegetation cover that sheltered the enemy and camouflaged the Ho Chi Minh trail, a network of roads and tracks used by the communists in the North to supply South Vietnam. One kilogram of artillery wipes out over 12 m² of vegetation cover. The amplitude of the environmental effects of such an attack was appalling: between 8 000 and 40 000 km² are estimated to have been deforested just over this study zone, amounting to 70% of its surface area.

This massive destruction of tropical forest was followed by recolonization of land by herbaceous or scrubby vegetation that had been less completely uprooted. The whole process brought about a drastic reduction in average annual evapotranspiration[3] and a substantial increase in runoff in that area: over 50% more between 1972 and 1975, then 15% more between 1975 and 2004.

Flight from the war and its political consequences

The second study area, in northern Laos, experienced a massive exodus of its people: 730 000 to one million fled Laos, escaping from war and from the subsequent power take-over by the Pathet Lao[4] in 1975. These figures represent one-fifth of the country's inhabitants of the time. This region was also home to a large

number of Hmongs, who fought alongside the American army. Many of them fled to Thailand and the rest of the world at the end of the war.
The land in the area had traditionally been cultivated, but once abandoned it was recolonized by forest. The research team observed that the resulting rise in evapotranspiration and improved infiltration of water in the soil afforded by the regenerated vegetation brought a reverse trend, an average 30% decrease in runoff, between 1995 and 2004.

Only history can explain such changes

In spite of data deficiencies, the results of these studies show clear trends towards increase or decrease of the Mekong's discharge that were closely correlation with historical events and extensive land-use changes the region was subjected to during the 20th Century.
What other factors could have the potential for exerting an impact on runoff? The climate, often invoked as the major determinant of hydrological change, is not involved here: rainfall remained stable throughout the study period. As for hydroelectric dams, constructed from 1970 on the Mekong and sometimes blamed, they drain only 2% of the catchments investigated and therefore have only a slight influence on the river's discharge. Finally, urban expansion, a cause of possible increase in runoff, did not begin until the 1980s and is still a marginal phenomenon in Laos, where the demographic pressure remains low. Only the armed conflicts of the last Century can therefore explain such radical changes in runoff.
This study provides lessons from the past for reasoned use of land and sustainable management of water resources. Today, for other reasons, human impact continues to have repercussions on the region's hydrological regime. Intensive mining and extraction of timber, notably teak which is exported to the countries of the North, and clearance for agriculture. These new land uses could generate major problems in the short term, such as flooding or conversely water shortages, or pollution. They should be incorporated in public policies for water management in Laos.
Notes:

1. This research was conducted in conjunction with the International Water Management Institute and theNational Agriculture and Forestry Research Institutein Laos.
2. Mekong River Commission -- www.mrcmekong.org
3. combined effect of water evaporation from the soil and plant transpiration.
4. a Laotian political movement, originally nationalist and fighting for independence, then communist.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Institut de Recherche pour le Développement (IRD)**.

Journal Reference:

1. G. Lacombe, A. Pierret, C. T. Hoanh, O. Sengtaheuanghoung, A. D. Noble. **Conflict, migration and land-cover changes in Indochina: a hydrological assessment**. *Ecohydrology*, 2010; 3 (4): 382 DOI: 10.1002/eco.166

http://www.sciencedaily.com/releases/2011/03/110322115220.htm

Conch Shell Gives Nano Insights Into Composite Materials

Conch shell. The shells of sea snails are composed of about 95% calcium carbonate, the same material as crumbly chalk, yet they are a thousand times tougher. The other 5% is mainly organic matter. (Credit: iStockphoto/Brooke Fuller)

ScienceDaily (Mar. 22, 2011) — The conch shell, symbol of juvenile democratic power on a desert island in William Golding's Lord of the Flies, also harbours a secret power of its own. The shells of sea snails are composed of about 95% calcium carbonate, the same material as crumbly chalk, yet they are a thousand times tougher. The other 5% is mainly organic matter. Writing in the *International Journal of Materials Engineering Innovation*, researchers at the University of Cambridge use the example of the conch shell as an illustration of toughness-by-architecture in the quest for new synthetic materials for engineering, construction and aerospace applications.

David Williamson and Bill Proud review how these organisms build such tough shells from such a seemingly weak substance. They discover that the key to conch strength lies in the small size of the calcium carbonate crystals from which it is formed by the sea snail. The crystals are below a threshold size known as the Griffith flaw size, any bigger and the crystals would be large enough for cracks to propagate through them under stress, the team explains. This makes the shells tough enough to cope, to some extent, with the crushing jaws of predatory turtles and the vice-like grip of crab claws. Weight for weight the shells are as tough as mild steel.

In the early twentieth century, engineers were preoccupied with the premature failure of materials used in shipping and railways. Concepts such as stress magnification and the propagation of tiny cracks that grow to form big cracks were beginning to be understood. Civil engineer Charles Edward Inglis Inglis devised a mathematical equation to help explain the process. And, in 1920, Alan Arnold Griffith built on the Inglis work to explain for the first time that the reason materials in the real world are not as strong as theoretical calculations would suggest is that the presence of tiny flaws magnify the applied stress in a manner according to the Inglis analysis leading to premature failure.

"Griffith pointed out that the effective strength of technical materials might be increased many tens of times if these flaws could be eliminated," explain Williamson and Proud. Little was known at the time of biomaterials and how their properties might one day copied to create biomimetic materials of much greater strength than their industrial counterparts. Griffith's work has now been used to improve our understanding of conch shells and other biomaterials to allow scientists to produce novel composite biomimetic materials. Research in this area has seen almost exponential growth in the last decade.

The team explains that in the archetypal conch shell material, the queen conch (*Strombus gigas*) uses a crossed layered, or lamellar, structure. At the smallest length scale the shell is made from tiny crystals of calcium carbonate in the so-called orthorhombic polymorphic form of aragonite. Each single crystal is a mere 60 to 130 nanometres thick and about 100 to 380 nanometres across, although they can be several micrometres long. A nanometre is a billionth of a metre; a micrometre is a thousand times bigger, a millionth

of a metre. These dimensions, the Cambridge team explains are below the critical flaw size described by Griffith almost a century ago.
To make a biomimetic material, researchers might first adopt the small crystal size for their composites as well as the crossed layered structure of the conch shell. However, to be truly biomimetic, such materials will also have to incorporate another critical feature of the living material: the ability to self-heal. Attacked by a hungry turtle the shell of a queen conch might be strong enough to deter the predator, but damage will occur, but living tissue can carry out repairs. Materials scientists have discovered that certain polymers can be heat treated so that they undergo self-healing, extended research might allow crystalline composites that mimic conch shell to be made that have the same property.
The team concludes that, it is important to treat these biomaterials as sources of inspiration, rather than prototypes to be replicated in exquisite detail. After all, if nature had access to a modern, high-tech material like the extremely tough ceramic titanium boride used in aluminium smelting equipment and electrical discharge machining, would seashells look the same as they do now?

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Inderscience**, via AlphaGalileo.

Journal Reference:

1. David Williamson and Bill Proud. **The conch shell as a model for tougher composites**. *Int. J. Mater. Eng. Innovat*, 2011, 2, 149-164

http://www.sciencedaily.com/releases/2011/03/110322110026.htm

The Pacific Oyster Is in Sweden to Stay

Pacific oyster (Crassostrea gigas) in shallow water. (Credit: Image courtesy of University of Gothenburg)

ScienceDaily (Mar. 22, 2011) — The Pacific oyster was discovered in large numbers along the west coast of Sweden in 2007. The mortality rate in some places during the past two winters has been 100%, but researchers at the University of Gothenburg who have studied the Pacific oyster can now say that the species copes with cold winters and is here to stay.

The Pacific oyster has proved to be tolerant of low temperatures. Large populations of the oyster remained after the harsh winter of 2009/2010. In 18 locations studied along the Bohuslän coast, the mortality rate ranged between 32% and 100%, and averaged 84%. The survival rate for the oysters increased with increasing depth. Some oyster sites consequently still have large populations of living oysters.

"Pacific oysters that were exposed to low air temperatures by low water levels or were frozen in ice died during the first winter (this could refer to the winter 2007, change to the first of the two latest winters, or something similar?), while those that were beneath the ice coped well," says the researcher Åsa Strand of the Department of Marine Ecology at the University of Gothenburg.

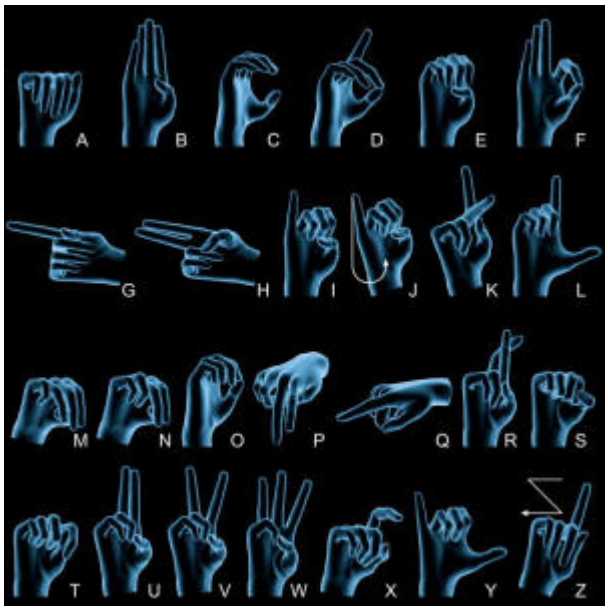
This year's winter (December to February) was warmer than last year, and the water level was generally higher. No major mortality can therefore be expected this winter, as those oysters that would be in the risk zone already died last winter. However, Pacific oysters born in 2010 are at great risk of dying during the winter if they have settled in shallow water. Strand and her colleagues will therefore study morality after this year's winter at the end of May and beginning of June. The fact that the Pacific oyster survived the winter of 2009/2010 means that it is, in all probability, here to stay.

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of Gothenburg**, via AlphaGalileo.

http://www.sciencedaily.com/releases/2011/03/110322105738.htm

Sign Language Users Read Words and See Signs Simultaneously



Sign language depicting the alphabet (A to Z). (Credit: iStockphoto/David Marchal)

ScienceDaily (Mar. 22, 2011) — People fluent in sign language may simultaneously keep words and signs in their minds as they read, according to an international team of researchers.

In an experiment, deaf readers were quicker and more accurate in determining the meaningful relationship between English word pairs when the word pairs were matched with similar signs, according to Judith Kroll, Distinguished Professor of Psychology, Linguistics and Women's Studies, Penn State. The slightly better reaction time and improved accuracy rate indicates that the readers are able to juggle both English and sign language at the same time.

"If a sign language user is a bilingual juggler they might not respond to the connections between the signs and words in a conscious way," said Kroll, who serves as the director of Penn State's Center for Language Science. "But we can design experiments to measure the unconscious response."

The study shows that sign language users are similar to other bilinguals, said Kroll, who also worked with Jill Morford, professor, University of New Mexico; Erin Wilkinson, assistant professor, University of Manitoba; Agnes Villwock, student, University of Hamburg; and Pilar Pinar, associate professor, Gallaudet University.

"This reflects previous research on bilinguals that shows both languages are active even when they're reading or speaking one language," Kroll said.

According to Morford, who was the lead author for the study, the research also represents the growing acceptance among the scientific community that sign language is a real language.

"This work is critical to help make the science of studying American Sign Language every bit as rigorous as the study of other languages," said Morford.

The researchers, who released their findings in a recent issue of *Cognition*, tested 19 deaf adults who were fluent in American Sign Language as they decided whether pairs of English words were related or unrelated in meaning.

A total of 120 word pairs was divided into two groups of 60 word pairs that had either related or unrelated meanings. Of the related pairs, such as bird-duck, 14 also had similar signs while 16 of the unrelated word pairs had similar signs. In ASL, signs are considered related if they have similar hand shapes, locations, movements or orientations. The researchers added a number of randomly assigned word pairs to complete the test.

When the participants encountered word pairs and signs that were related, the reaction time was significantly faster and more accurate than the reaction of a control group made up of 15 bilingual speakers who spoke English as a second language.

When the word pairs were matched with unrelated signs, the participants' reaction time was slower and less accurate.
"You see interference," said Kroll. "The reaction isn't slowed down enough to cause issues in the day-to-day usage of the language, but there's a momentary gap in processing that indicates that the bilingual is not processing information like monolinguals."
The research conducted on ASL by Penn State's Center for Language Science (CLS), in collaboration with the National Science Foundation's Science of Learning Center on Visual Language and Visual Learning (VL2) at Gallaudet University, was supported by the NSF's Science of Learning Center Program and the National Institutes of Health. CLS and VL2 are partners in a new NSF project awarded to Penn State as part of the partnerships for international research and education program.

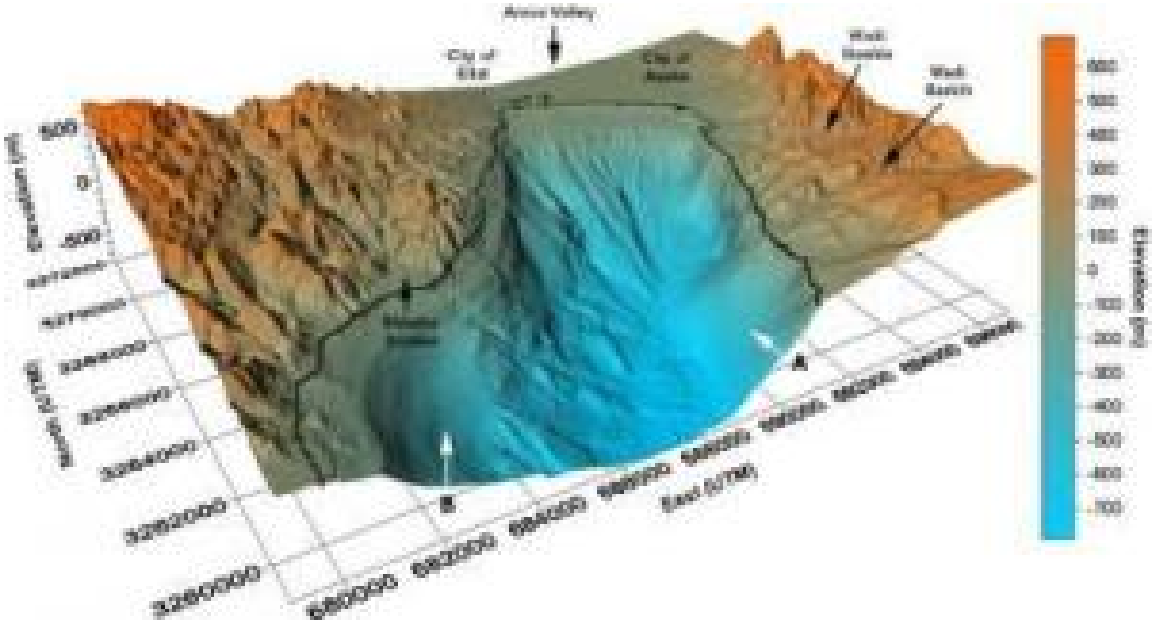
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Penn State**.

Journal Reference:

1. Jill P. Morford, Erin Wilkinson, Agnes Villwock, Pilar Piñar, Judith F. Kroll. **When deaf signers read English: Do written words activate their sign translations?** *Cognition*, 2011; 118 (2): 286 DOI: 10.1016/j.cognition.2010.11.006

http://www.sciencedaily.com/releases/2011/03/110322105438.htm

Fault-Finding Coral Reefs Can Predict the Site of Coming Earthquakes



This is a 3-D illustration of the Gulf of Aqaba Sea floor and surrounding mountains. (Credit: AFTAU)

ScienceDaily (Mar. 21, 2011) — In the wake of the devastating loss of life in Japan, the urgent question is where the next big earthquake will hit. To answer it, geologist Prof. Zvi Ben-Avraham and his doctoral student Gal Hartman of Tel Aviv University's Department of Physics and Planetary Sciences in the Raymond and Beverly Sackler Faculty of Exact Sciences are examining coral reefs and submarine canyons to detect earthquake fault zones.

Working with an international team of Israelis, Americans and Jordanians, Prof. Ben-Avraham and his team are developing a new method to determine what areas in a fault zone region are most at risk. Using a marine vessel, he and his colleagues are surveying a unique geological phenomenon of the Red Sea, near the coastal cities of Eilat and Aqaba -- but their research could be applied anywhere, including Japan and the west coast of the U.S.

Recently published in the journal *Geo-Marine Letters,* the research details a "mass wasting" of large detached blocks and collapsed walls of submarine canyons along the gulf region of the Red Sea. They believe the geological changes were triggered by earthquake activity.

What's next for San Andreas?

The team has created the first underwater map of the Red Sea floor at the head of the Gulf of Aqaba, and more importantly, identified deformations on the sea floor indicating fault-line activity. They not only pinpointed the known fault lines along the Syrian-African rift, but located new ones that city engineers in Israel and Jordan should be alert to.

"Studying fossil coral reefs and how they've split apart over time, we've developed a new way to survey active faults offshore by looking at the movement of sediment and fossil structures across them," says Hartman. "What we can't say is exactly when the next major earthquake will hit. But we can tell city engineers where the most likely epicenter will be." According to Hartman, the tourist area in the city of Eilat is particularly vulnerable.

While geologists have been tracking underwater faults for decades, the new research uniquely tracks lateral movements across a fault line (a "transform fault") and how they impact the sediment around them. This is a significant predictive tool for studying the San Andreas Fault in California as well, says Hartman.

The research is supported by a USAID grant through the Middle East Regional Cooperation (MERC) program.

Marching orders for city engineers

Aboard a marine vessel that traversed the waters of Israel and Jordan and peering at depths as deep as 700 meters, the researchers analyzed the structure of the seabed and discovered active submarine canyons, mass wasting, landslides, and sediment slumps related to tectonic processes and earthquake activity.
"There are several indicators of seismic activity. The most significant is the location of the fault. Looking at and beneath the seafloor, we saw that the faults deform the upper sediments. The faults of the Red Sea are active. We managed to find some other faults too and now know just how many active faults are in the region. This should help make authorities aware of where the next big earthquake will strike," says Hartman.
What made their study particularly unique is that they used the offset along linear structures, of fossil coral fringing-reefs to measure what they call "lateral slip across active faults." With this knowledge, researchers were able to calculate total slip and slip-rates and how active the fault has become.
"We can now identify high-risk locations with more certainty, and this is a boon to city planners. It's just a matter of time before we'll need to test how well cities will withstand the force of the next earthquake. It's a matter of proper planning," concludes Hartman.

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

Journal Reference:

1. Gideon Tibor, Tina M. Niemi, Zvi Ben-Avraham, Abdallah Al-Zoubi, Ronnie A. Sade, John K. Hall, Gal Hartman, Emad Akawi, Abdelrahmem Abueladas, Rami Al-Ruzouq. **Active tectonic morphology and submarine deformation of the northern Gulf of Eilat/Aqaba from analyses of multibeam data**. *Geo-Marine Letters*, 2010; 30 (6): 561 DOI: 10.1007/s00367-010-0194-y

http://www.sciencedaily.com/releases/2011/03/110321134615.htm

Developing Strategies in a Desert Watershed That Sustain Regional Water Supplies

Technician Jim Riley (left) and hydraulic engineer Dave Goodrich download water-level data from the Rostrin Basin, a flood detention pond in Sierra Vista, Arizona, which will aid in calculating the recharge rate to the ground-water aquifer. (Credit: Photo by Stephen Ausmus)

ScienceDaily (Mar. 22, 2011) — U.S. Department of Agriculture (USDA) scientists are helping meet the water demands of a riparian desert region that is home to a national conservation area and a thriving military base.

Agricultural Research Service (ARS) hydraulic engineer Dave Goodrich and hydrologist Russ Scott have been part of Arizona's Upper San Pedro Partnership (USPP)-a mix of 21 federal, state, and local groups managing the region's water-supply needs-since the association started in 1998. ARS is USDA's chief intramural scientific research agency, and this work supports the USDA priority of responding to climate change.

Fort Huachuca, which is the primary economic engine in the upper San Pedro River valley, draws its water from the aquifer that sustains the desert river, but this groundwater is being depleted more rapidly than it is replenished. In 2004, Congress directed the Department of the Interior to work with the Department of Defense, USDA and the USPP to develop water use management and conservation measures that would restore and maintain water supplies in the upper San Pedro watershed.

Goodrich and Scott both work at the ARS Southwest Watershed Research Center in Tucson, Ariz. The scientists are studying how much water is used by riparian vegetation and evaluating how storm water runoff from urban development affects groundwater reserves.

As part of this work, Goodrich and others measured storm water runoff from undeveloped land at the edge of Fort Huachuca and from a newly developed area just outside the military installation. They found that a third of the runoff from the developed site resulted just from the compaction from the surface soils during construction-and not from the installation of impervious barriers, as they had expected.

Meanwhile, Scott and his colleagues found that mesquite woodlands use much more water than cottonwood and willow trees that grow along the riverbanks. He used this finding to develop a GIS-based riparian

evaporation and transpiration tool that regional land managers can use to estimate water savings by replacing mesquite with native desert grasses.
Results from this work have been published in *Global Change Biology*, the *Journal of Contemporary Water Research and Education*, *Southwest Hydrology*, and elsewhere.
Read more about this research in the March 2011 issue of *Agricultural Research* magazine at:
http://www.ars.usda.gov/is/AR/2011/mar11/river0311.htm

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **USDA/Agricultural Research Service**. The original article was written by Ann Perry.

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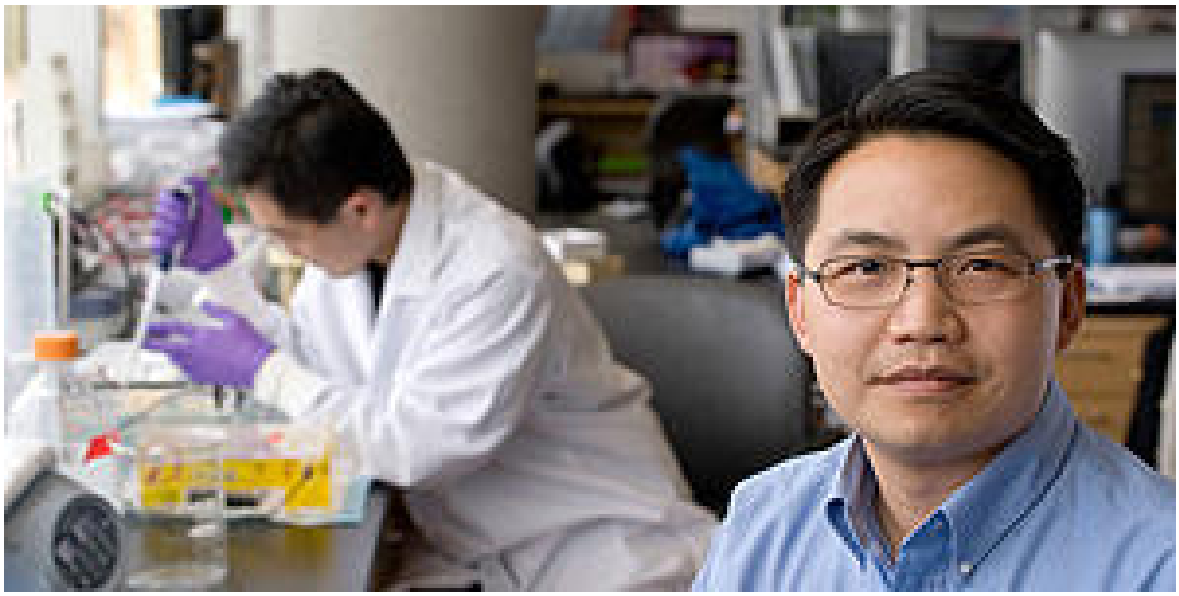
http://www.sciencedaily.com/releases/2011/03/110322114829.htm

Molecular Determinant of Cell Identity Discovered



Howard Chang and his team have discovered how cells decide which proteins they will tend to produce. (Credit: Steve Fisch)

ScienceDaily (Mar. 21, 2011) — If a big bunch of your brain cells suddenly went rogue and decided to become fat cells, it could cloud your decision-making capacity a bit. Fortunately, early in an organism's development, cells make firm and more-or-less permanent decisions about whether they will live their lives as, say, skin cells, brain cells or, well, fat cells.

Those decisions essentially boil down to which proteins, among all the possible candidates encoded in a cell's genes, the cell will tend to make under ordinary circumstances. But exactly how a cell chooses its default protein selections from an overwhelmingly diverse genetic menu is somewhat mysterious.

A new study from the Stanford University School of Medicine may help solve the mystery. The researchers discovered how a particular variety of the biomolecule RNA that had been thought to be largely irrelevant to cellular processes plays a dynamic regulatory role in protein selection. In unraveling this molecular mechanism, the study also offers enticing clues as to how certain cancers may arise.

Howard Chang, MD, PhD, associate professor of dermatology, is the senior author of the study, to be published online March 20 in *Nature*.

"All the cells in your body have the same genes, but they don't all make the same proteins," said Chang, MD, PhD, who is also a Howard Hughes Medical Institute Early Career Scientist. In this new study, Chang and his colleagues identified a novel action by a subset of RNA that reinforces cells' decisions about which combinations of their genes are to be active and which must stay silent.

RNA is a chemical lookalike of DNA -- the stuff our genes are made of -- that, according to standard textbooks, mainly functions as a messenger: a copy of a gene, made by a cell's gene-reading machinery, that can float away from the chromosomes where genes reside to other places in the cell where proteins are made. There the messenger-RNA molecule serves as an instruction manual for the production of proteins.

Scientists used to see RNA mostly as a stodgy servant of its kingly commander, DNA, in the protein-production process. But in recent decades scientists have learned of several ways RNA can influence the production of proteins besides merely conveying information from genes to a cell's protein-making apparatus.

In the Nature study, the researchers identified a novel regulatory role for a class of RNA molecules called lincRNA (for long intergenic noncoding RNA). A typical cell spawns as many as 10,000 distinct species of lincRNA molecules -- on a par with the number of conventional protein-coding genes -- but lincRNAs don't spell out recipes for making proteins. For years, many biochemists were skeptical that lincRNA played any important role in a cell and considered the molecules just mere "noise," perhaps vestigial protein-coding genes that had mutated to become nonfunctional. Chang's group has been instrumental in proving that

lincRNAs can play a critical regulatory role: determining what proteins a cell produces and, thereby, what identity it assumes.
To do so, Chang and his associates turned to human fibroblasts, which are easily grown in culture. Fibroblasts are cells that lie just beneath the skin and secrete factors determining skin cells' local character. "You'll never see hair growing out of someone's palm," Chang said. The factors that fibroblasts secrete vary depending on where in the body they're located.
Remarkably, cultured fibroblasts from different parts of the body somehow remember their sense of where they belong, continuing to maintain characteristic patterns of genes that are "on" or "off" even over dozens of generations of cell division in a petri dish. "Why is that?" Chang asked.
A related question intrigued the study's first author, Kevin Wang, MD, PhD, an instructor of dermatology and a postdoctoral scholar in Chang's lab. "I was initially interested in conditions like psoriasis, a skin disease whose manifestations in the body are region-specific," he said. "Cells that have the same DNA, that look the same under a microscope -- what made them act differently?"
Chang has been using cultured fibroblasts as workhorse cells to help answer these questions. In a study published last year in Science, his group showed that one species of lincRNA, which he and his labmates had discovered and named HOTAIR, acts quite differently from your standard mRNA molecule: It contorts into a kind of adapter plug and then latches onto massive protein complexes, which have the ability to silence genes. Once hooked up to such complexes, HOTAIR shuttles them to particular spots along a chromosome -- "positional identity" genes. Defects in these genes, first identified in fruit flies, can result in bizarre outcomes such as a fly with legs growing out of its head, instead of antennae. Particular on/off patterns of a cell's positional-identity genes lead the cell to behave in a characteristic way (palm versus scalp, for example).
In a nutshell, HOTAIR locks cells' positional identities into place by marking key genes with the biochemical equivalent of "gone fishing" signs, so that they remain closed for business.
The new study, in contrast, demonstrates how another lincRNA, dubbed HOTTIP, grabs onto an opposing type of protein complex, which marks similar positional-identity genes as "open for business." The researchers observed that this complex wheels into action once HOTTIP links to it, and then biochemically fixes cell-position-appropriate genes in the "on" position.
An ability to act as a mute button for protein production has been demonstrated for other RNA types besides lincRNA. But, said Chang, HOTTIP is the first example of any RNA molecule that creates a memory of gene activation rather than silencing them. "When we experimentally impeded HOTTIP activity, fibroblasts that were supposed to express certain positional-identity genes didn't," he said.
Interestingly, the particular genes that HOTTIP caused to retain a switched-on status were fairly remote from one another along the stretch of chromosome where they reside. To learn more about how this works, Chang, Wang and their Stanford colleagues teamed up with a group at the University of Massachusetts Medical School, in Worcester, whose research focuses on the three-dimensional organization of genomes.
What they learned from this holds implications for how some cancers could get started. The investigators found that DNA can form complicated looping structures that bring genes distant from one another on a chromosome, or on entirely different chromosomes, physically close. This lets HOTTIP and the protein complex it's linked to efficiently mark appropriate genes as "open for business."
But it could also lead to things going awry, possibly triggering certain cancers. Biochemical interactions at close range among these ordinarily distant genes can cause their fusion -- or even an exchange in their positions -- and resulting faulty protein production characteristic of a number of cancers, Chang said.
The study was funded by the California Institute for Regenerative Medicine, the National Institutes of Health, the Scleroderma Research and W.M. Keck foundations and the Howard Hughes Medical Institute. Other Stanford co-authors are Joanna Wysocka, PhD, assistant professor of chemical and systems biology and of developmental biology; Jill Helms, PhD, DDS, professor of surgery; Rajnish Gupta, MD, PhD, clinical assistant professor of dermatology; Bo Liu PhD, a research associate in Helms' laboratory; medical and graduate student Yul Yang; graduate student Ryan Corces-Zimmerman; medical student Ryan Flynn; and research assistant Angeline Protacio. In addition to the team at the University of Massachusetts, the study also involved a researcher at the University of Michigan.

Story Source:

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Journal Reference:

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http://www.sciencedaily.com/releases/2011/03/110321093658.htm

New lead on deadly pancreatic cancer

Mouse model reveals mechanism of potential therapy for lethal tumours.

Alison Abbott

A clinical trial run in both mice and humans has examined a new way to attack pancreatic cancer.STEVE GSCHMEISSNER / SCIENCE PHOTO LIBRARY

There are currently no effective weapons against pancreatic ductal adenocarcinoma, for which death usually follows diagnosis by just months.

But scientists have stumbled across an unexpected way to break through the cancer's formidable defences in clinical trials involving humans and, unusually, mice. Their results are published today in Science[1].

Robert Vonderheide, an immunologist at the University of Pennsylvania's Abramson Cancer Center in Philadelphia, and his team activated immune cells that chewed holes in the protective shell, or stroma, that the pancreatic cancer builds around itself, and attacked the tumour cells.

Surprisingly, the immune cells involved were not the usual suspects — sophisticated anti-tumour T cells — but more primitive cells called macrophages.

"This opens up a fresh set of possibilities for seeking new treatments," says Terry Van Dyke, head of the Mouse Cancer Genetics Program at the National Cancer Institute in Frederick, Maryland, who was not involved in the study. "It's a clear indication that activating macrophages will be efficacious."

Breaking the barrier

It is the unusually tough stroma surrounding pancreatic ductal adenocarcinomas that is responsible for the disease's poor prognosis. Not only is it almost entirely impenetrable to drugs, but it also becomes enmeshed with white blood cells that prevent the immune system from launching its own attack on the cancer.

Others have designed molecular strategies to attack the stroma in the hope of facilitating drug access, and these are currently being tested in the clinic. But the stromal assault by Vonderheide's team occurred inadvertently.

The authors' original intention was to try to counteract the stroma's immunosuppressive actions by activating the protein CD40. This protein activates many types of immune cell, although it is best known for its ability to activate anti-tumour T cells. And it was on these that the scientists focused their attention, expecting the activated T cells to slip through the stroma and target the cancer.

They carried out a clinical trial on 21 patients with inoperable pancreatic cancer who were being treated with gemcitabine, the standard chemotherapy drug for the disease. They gave the patients additional injections of an experimental CD40-activating antibody.

On average, the 21 patients survived several weeks longer than would have been expected without the antibody treatment, and four patients exhibited temporary regression of their tumours. The authors examined biopsies from two of the shrunken tumours under the microscope and found them stuffed with macrophages but devoid of T cells.

"Even before the patient trial had finished, we realised that the therapy was looking successful, but perhaps not for the reasons we had imagined," says Vonderheide.

Antibody action

To establish the underlying mechanism, the scientists turned to mice that had been genetically engineered to develop a cancer similar to human pancreatic ductal adenocarcinoma. They were able to repeat the human trial in the animals, with a full set of controls, and subject them to more detailed and invasive examinations.

They treated one set of animals with gemcitabine and a mouse version of the CD40-activating antibody, and other sets with gemcitabine alone, antibody alone or no drugs. Tumours regressed in 30% of mice treated with the antibody — whether or not they had also received gemcitabine. "It was also a surprise to find that gemcitabine itself was not contributing much to the therapeutic effect," says Vonderheide.
The authors then took a close look at how the immune systems of the mice, and their tumours, had responded to CD40 activation.
"The antibody did actually cause T cells to be activated, but for some reason they remained in lymph nodes and didn't migrate to the tumours," says Vonderheide. Instead, they found activated macrophages swarming into tumours, he says — and also hanging around the stroma, which started to curl inwards and break down.
"This discovery could never have been made without using a mouse model of the cancer to dissect out the mechanism in detail," says Van Dyke, who recently moved to the National Cancer Institute to start a big translational medicine programme that will similarly match patient and mouse clinical trials in several cancers. Many such efforts are springing up around the world, including a large programme at Harvard in Cambridge, Massachusetts, launched with US stimulus money.
"Despite a lot of effort, only one new drug, erlotinib, has been approved by the Food and Drug Administration in the last decade for metastatic pancreatic cancer, and that only prolongs life by two weeks," says Vonderheide. "Maybe our discovery will lead to new ideas about how to manipulate the immune system for best therapeutic effect."

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http://www.nature.com/news/2011/110324/full/news.2011.186.html

Stone tools cut swathe through Clovis history

Dig uncovers previously unknown North American culture.

The artefacts found indicate a more migratory culture than the sedentary Clovis.Courtesy of Michael R. Waters

The long-standing idea that the Clovis people of ancient North America were the first tool-using humans on the continent 13,200 years ago is being overturned by the discovery of human artefacts in a Texan creek bed that are even older.

Michael Waters, a geoarchaeologist at Texas A&M University in College Station, and his team unearthed more than 15,000 stone artefacts from the Debra L. Friedkin archaeological site in Texas. Using luminescence dating, which dates the last time samples were exposed to sunlight, the researchers found that the artefacts are between 13,200 and 15,500 years old. They seem to have been left undisturbed by any sort of soil movement, suggesting that the artefacts come from a time before the Clovis people came to dominate the landscape.

"With these sorts of soils it is easy for objects to move around over time, but with 15,000 artefacts in the pre-Clovis horizon that would involve a whole lot of transport," says Rolfe Mandel, a geoarchaeologist at the University of Kansas in Lawrence who was not involved in the study, which is published online today in Science[1]. "A lot of archaeological studies like this have problems, but this one is about as perfect as they come, there is little to question here."

The finding does not, however, suggest that the Clovis people simply lived in North America earlier than previously believed. Instead, it hints that a different group of people using different tool types was present during the earlier years. This group could have been replaced by or culturally evolved into the Clovis.

Although most of the newly recovered artefacts are debris such as bits of chipped stone, Waters and his team have uncovered 56 stone tools made from chert. Twelve of these are bifaces, two-sided sharp-edged stone tools made through flaking and chipping. They seem to have been used as knives and choppers on both soft and hard materials. Crucially, a few of these tools are similar to the iconic, lance-like spear points that the Clovis people made, but they are simpler and recognizably different.

"The tools seem to be locally technologically ancestral to those used by the Clovis," says James Adovasio, an archaeologist at Mercyhurst College in Pennsylvania.

The toolkit of these pre-Clovis people is also lighter than that used by the Clovis culture. "This suggests they were mobile hunter–gatherers, readily moving across the landscape — quite different from the Clovis people who had heavier tools and were sedentary," says Waters.

Last nail in the Clovis coffin

It is not entirely surprising that the Clovis people developed their impressive spear points in southern North America from simpler tools. Genetic studies indicate that the Clovis people hailed from northeast Asia. The only plausible path for them to have made it to North America was via a gruelling journey over the Alaskan land bridge, which once connected Asia and North America and through glacial corridors in Canada. "People have assumed that they developed their spear points along the journey into North America and then quickly used them to drive many species to extinction," says Adovasio. Yet none of the iconic Clovis spear tips has ever been found in Asia, in Alaskan sediments dating to the time when they probably made their migration or in the Canadian glacial corridor.

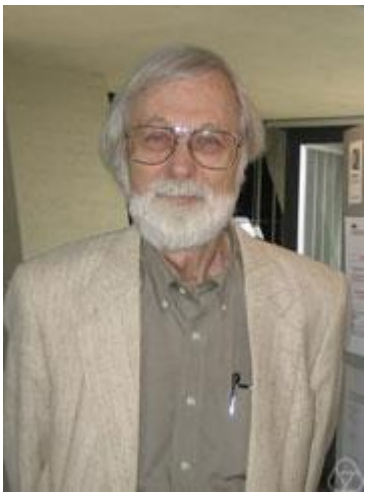
"It never made sense to me that the spear points originated during the migration. Now that we have biface technology at pre-Clovis sites in the continental United States, it seems that this is where Clovis technology developed and spread from," says Waters.

"I think we can safely say this work puts another nail in the Clovis-first coffin," says Adovasio.

http://www.nature.com/news/2011/110324/full/news.2011.185.html

Maths polymath scoops Abel award

John Milnor wins 'Nobel of maths' for his manifold works.
Philip Ball



John Milnor, now 80, has contributed to fields from geometry to number theory.G.-M. Greuel/Wikipedia

In retrospect, giving Albert Einstein a Nobel prize for his work on the photoelectric effect looks like an arbitrary choice from among all of his contributions to physics.

In granting the 2011 Abel Prize in mathematics to John Milnor of Stony Brook University in New York, the committee of the Norwegian Academy of Science and Letters has wisely avoided singling out a particular achievement. The citation states merely that Milnor has made "pioneering discoveries in topology, geometry and algebra". In effect, this is a recognition that he has contributed to maths across the board.

In fact, Milnor's work goes further: it also touches on dynamical systems, game theory, group theory and number theory. In awarding this equivalent of a Nobel prize, worth about US$1 million, the committee states that: "All of Milnor's works display marks of great research: profound insights, vivid imagination, elements of surprise, and supreme beauty."

Milnor's breadth is unusual, says Ragni Piene, a mathematician at the University of Oslo who chairs the Abel committee. "Though some of the fields he has worked in are related, he really has had to learn and develop new tools and new theory."

Milnor "says he is mainly a problem solver", adds Piene. "But in the solving process, in order to understand the problem deeply he ends up creating new theories and opening up new fields."

Exotic spheres

Among the most surprising of Milnor's discoveries was the existence of 'exotic spheres' — multidimensional objects with strange topological properties. In 1956, Milnor was studying the topological transformations of smooth-contoured high-dimensional shapes — that is, shapes with no sharp edges. A 'continuous topological transformation' converts one object smoothly — as though remoulding soft clay — into another, without any tears in the fabric.

He discovered that in seven dimensions there exist smooth objects that can be converted into the seven-dimensional equivalent of spheres only via intermediates with sharp kinks.

These exotic spheres can exist in other dimensions. With the French mathematician Michel Kervaire, Milnor calculated that there are 28 exotic spheres in 7 dimensions. But there seems little rhyme or reason to the trend for other dimensions: there is one exotic sphere in 1, 2, 3, 5 and 6 dimensions, 992 in 11 dimensions, 1 in 12 dimensions, 16,256 in 15, and 2 in 16. No one has figured out how many there are in four dimensions. This work spawned an entire new field of mathematics, called differential topology.

Some of Milnor's other achievements are related to similar topological conundrums, such as his work on the relationships between different triangulations (representations as networks of triangles) of mathematical surfaces called manifolds. Topology was also central to some of Milnor's earliest work in 1950 on the curvature of knots.

Trajectory of awards

Milnor's work on group theory is quite different. Group theory was partly invented by the nineteenth-century Norwegian mathematician Niels Henrik Abel, after whom the award is named. In the formulation developed by Abel, a group can be represented as all non-equivalent combinations ('words') of a set of symbols. Milnor and the Czech mathematician Frantisek Wolf clarified how the number of words grows as the number of symbols increases for a wide class of groups called solvable groups.

More recently, Milnor, now 80, has been working in the field of holomorphic dynamics, which concerns the patterns made when the same equation is performed time and again with different inputs. This branch of maths led to the discovery of fractal patterns such as the Mandelbrot and Julia sets.

Milnor has already won just about every other key prize in mathematics, including the Fields Medal (1962) and the Wolf prize (1989). Aside from his skills as a researcher, Milnor has been widely praised as a communicator. His books "have become legendary", says mathematician Timothy Gowers of the University of Cambridge, UK.

http://www.nature.com/news/2011/110323/full/news.2011.182.html

Cancer: Missing the mark
Why is it so hard to find a test to predict cancer?
Lizzie Buchen

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On 3 March, two studies appeared online that offered 19 pages of gloomy reading for anyone interested in cancer. They focused on biological molecules, or biomarkers, the presence of which in the blood might be used to detect the earliest glimmers of ovarian cancer — a disease not normally discovered until it has destroyed the ovaries and rotted other parts of the body. The researchers, coordinated by the Early Detection Research Network (EDRN) of the US National Cancer Institute (NCI), had assembled 35 protein biomarkers, including 5 panels of proteins, that had looked the most promising in early studies. They had carried out rigorous testing — screening blood samples from more than 1,000 women — to ask whether these seemingly breakthrough biomarkers were better at identifying women with early ovarian cancer than the one flawed biomarker that had been in use for almost 30 years, CA-125. None of them was[1,2]. "CA-125 remains the 'best of a bad lot'," read an accompanying perspective article[3]. "The new candidates have fallen short of expectations."

Tied in last place for its poor performance among the biomarker panels was one identified by Gil Mor, a cancer biologist at Yale University in New Haven, Connecticut. Mor's six-protein panel detected ovarian cancer in only 34% of the women who were diagnosed with the disease within a year. (CA-125, by contrast, detected 63%.) Mor's panel already had a tortured history. A primary research paper behind it had been criticized by other scientists for allegedly using inappropriate statistical calculations and for optimistically concluding that the test would help women before rigorous follow-up studies proved that it could. Yet for four months in 2008, the test was sold to patients by Laboratory Corporation of America (LabCorp) in Burlington, North Carolina, the company that licensed the panel from Yale. LabCorp had marketed the test under the name OvaSure until the US Food and Drug Administration (FDA) intervened and the company pulled it from the market. The panel offered "invaluable object lessons" for bringing a test prematurely to the clinic, wrote the authors of the perspective article.

“As we're moving up to multiple markers, all our bad habits are coming back to bite us in a big way.”

Similar lessons can be found in the stories behind many cancer biomarkers that have sputtered and failed on their way to the clinic. Those tests that are in clinical use — including prostate-specific antigen (PSA) for prostate cancer, mammogram-detected masses for breast cancer and CA-125 — fail to detect all cancers and sometimes 'detect' ones that aren't there. Genomics, proteomics and other such technologies promised to help by finding combinations of markers that are more powerful and cancer-specific than individual ones, but that promise has not been realized. Researchers using such technologies have published studies on thousands of panels, suggesting that they can detect early-stage disease, guide patient treatment and monitor recurrence. But only a tiny number of such tests have reached the clinic — and none for the early detection of cancer, the biggest clinical challenge of all. "Much biomarker research has been done very badly for decades," believes Lisa McShane, a biostatistician at the NCI in Rockville, Maryland. "Even when it was single markers. Now, as we're moving up to multiple markers, all our bad habits are coming back to bite us in a big way."

These habits have been thrown into the spotlight by the EDRN's study, one of the largest and most systematic validation studies of biomarkers so far. It came just months after a high-profile decision at Duke University in Durham, North Carolina, to suspend clinical trials of a genomics-based biomarker panel designed to direct chemotherapy in patients with breast cancer. A number of scientists had raised concerns about the Duke group's data and analysis, and the trial was stopped after allegations came to light that the lead researcher, geneticist Anil Potti, had made false claims on his CV. Last September, the Institute of Medicine (IOM), part of the US National Academies, assembled a committee to discuss lessons for developing tests based on 'omics' technologies and bringing them to the clinic. "Why don't we have assays out there, with this enormous promise?" Dan Hayes, a breast-cancer researcher at the University of Michigan in Ann Arbor asked researchers at the first IOM committee meeting in December 2010."It's either because these things just don't work, or because we've used sloppy science to test them."

It is too early to say whether either of these is true: the field is still young, and faces many challenges. It has drawn in many cancer biologists who are excited by the potential to translate their work to the clinic — but they sometimes lack the expertise or resources needed to pursue translational or clinical work. "A lot of novices came in. They get in without realizing that the problem may be more complex than it appears," says Eleftherios Diamandis, a clinical biochemist at the University of Toronto in Canada. And although most experts agree that potential biomarkers for early cancer detection should be validated on samples taken before diagnosis — the stage at which the test would be used in the clinic — that is a step that few groups attempt and no biomarker for ovarian cancer has passed, as the EDRN study made clear. "Sometimes the glamour of the technology or the sheer volume of omics data seem to make investigators forget basic scientific principles," said McShane at the IOM meeting. Mor agrees that the field has faced problems, and that it is important for markers to go through a careful process of design and validation, as he tried to do.

"There's been an enormous amount of hype and promise," sums up David Ransohoff, a cancer epidemiologist at the University of North Carolina in Chapel Hill. "But after 10 or 15 years of intense work in these fields, there's simply not a lot to show for it. It's important for the whole field to step back and look at what is wrong."

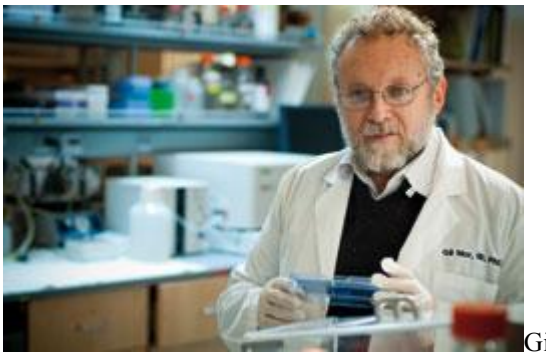
Making a difference

Mor began his career in Israel, where he trained as a clinician at the Hebrew University of Jerusalem. But an experience in the final years of his oncology residency compelled him to change course. A young woman arrived at the hospital with ovarian cancer, a disease that kills some 140,000 women worldwide each year. The oncology team removed the woman's ovaries and put her through several rounds of chemotherapy, which seemed to be successful. But 18 months later, she was back, her body riddled with tumours, and she soon died. "Chemotherapy didn't do anything for her," Mor recalls. "She was 29. She was a beautiful girl. An impressive girl. A medical student. And I never understood what happened to her."

Mor decided to leave medicine, which had been unable to save her, for research, which one day might. He earned a PhD studying ovarian cancer at the Weizmann Institute of Science in Rehovot, Israel, before moving to Yale in 1997. He went on to start a programme called Discovery to Cure, aiming to speed cancer research to the clinic. The group began to build a bank of blood and tissue samples, including some from a Yale clinic for women with a high risk of ovarian cancer owing to a family history of the disease."There was a lot of excitement around that time for finding proteins specific to cancer," says Mor.

In 2003, David Ward, then a geneticist at Yale, contacted Mor. Ward had co-founded Molecular Staging, a company in New Haven that had developed a 'high-throughput' technique for quantifying multiple proteins in the blood using arrays of antibodies[4]. He asked whether he could use Mor's samples to search for markers of early ovarian cancer.

Mor had never been involved with biomarker research — "I do biology of cancer, not biomarker development," he says — but he signed up, intrigued by the clinical potential of the technology. Ward had scoured the literature for proteins that had been associated with ovarian-cancer growth and malignancy, and had come up with 169 candidates. Using the protein-quantification technique, Ward's company screened blood samples in Mor's tissue bank that came from two groups: women with newly diagnosed ovarian cancer who had been enrolled in Yale's high-risk clinic, and women who had come to the hospital for routine gynaecological exams. Using additional cancer-patient samples, they whittled the list down to four proteins: leptin, prolactin, osteopontin and insulin-like growth factor II.


Gil Mor is testing whether a panel of six proteins can detect ovarian cancer in women at high risk.S. Ogden

Mor worked to develop an algorithm that could automatically classify women as having cancer or not, depending on levels of these four proteins. When the team ran a new set of blood samples through the algorithm, they got astounding results. The test showed a sensitivity of 95% (meaning it correctly detected 95% of the ovarian-cancer cases) and a specificity of 95% (it erroneously classified only 5% of healthy people as having cancer). "I was delighted," says Mor. On equivalent samples, CA-125 tests typically have a sensitivity of 70–80% and a specificity of around 95%. In May 2005, the findings were published in the Proceedings of the National Academy of Sciences (PNAS), with Ward as a contributing author[5].

Before publication, Mor helped the Yale Office of Cooperative Research to prepare a patent application. "A lot of companies expressed interest in licensing the panel," says John Puziss, director of technology licensing at Yale. LabCorp licensed the test in 2006, as did Millipore, a biomanufacturing company based in Billerica, Massachusetts. (Mor says that the royalties he and his co-inventors received "were not a significant amount".)

The test's promising results had also caught the attention of researchers in the EDRN, who were just putting together their validation study. Up to that point, most biomarkers for detecting early ovarian cancer had only been shown to distinguish patients with diagnosed cancer from healthy controls, but they are intended to detect the disease in women whose cancer is just budding, before symptoms develop. What the field needed was a 'prospective' study, run on blood samples from apparently healthy women, to see whether the biomarkers could pinpoint those who would later be diagnosed with ovarian cancer. Such samples, from large numbers of women who are tracked over months or years, are extremely difficult to come by.

Problem detection

The EDRN found what was needed in the Prostate, Lung, Colorectal, and Ovarian (PLCO) Cancer Screening Trial, sponsored and run by the NCI. Between 1992 and 2001, the trial had been collecting blood at regular intervals from 155,000 women and men, and screening them for cancer. By June 2006, 118 of the women had developed ovarian or closely related cancers, and the EDRN researchers were now in a position to use them to evaluate the most promising biomarkers for early detection. Ziding Feng, a biostatistician at the Fred Hutchinson Cancer Research Center (FHCRC) in Seattle, Washington, and coordinator of the EDRN, visited Mor to discuss whether his panel of four proteins could be included in the study.

“It's important for the whole field to step back and look at what is wrong.”

Mor was already in the process of refining the panel: he had more patient samples, and wanted to add more markers, including CA-125 and the protein macrophage migration inhibitory factor, to make the test more sensitive to cancer. LabCorp had been running his new samples on assay kits manufactured by Millipore. (Ward, meanwhile, had moved to the Nevada Cancer Institute in Las Vegas, and was not involved in data collection or analysis.)

When Mor showed Feng how he was analysing his recent data, Feng was troubled. Mor asked him to go through the new results himself, and Feng agreed to collaborate. "I do not do statistics," says Mor. "That is not my field." The researchers also added the six-protein panel to the EDRN's validation study.

Feng and Gary Longton, another statistician at the FHCRC, developed their own classification algorithms, and found that Mor's test had a sensitivity of 95% and specificity of 99%. They also calculated the positive predictive value (PPV) of the test — the proportion of patients who the test would diagnose with the disease and do in fact have it. A high PPV means that few people will be misdiagnosed, which is crucial when screening healthy people.

Feng and Longton calculated the PPV at 6.5%, too low for the test to be of much use for screening. But separately, Mor was working with a different figure, of 99.3%. The huge disparity between the two values stemmed from the way that they calculated the figure and factored in the prevalence of ovarian cancer — an important variable in calculating the PPV. Following convention, Feng and Longton calculated the PPV using the accepted prevalence in post-menopausal women, 1 in 2,500 (0.04%). But Mor's figure was calculated solely from the study population, in which the prevalence was 46%. "We calculated the PPV based on the population in the study, because we always intended the test for the high-risk population," says Mor. "If you want to bring the test to the clinic, it has to be calculated based on the population you're going to study," he says, noting that other research studies work out the PPV for the study population in this way.

It's a common mistake, believes McShane, who — like other statisticians — disagrees with Mor's logic. "I see that a lot, but it is nowhere near the correct thing to do," she says. Even in high-risk populations — women who are screened every year because of their family history or because they have tested positive for mutations in tumour-suppressor genes BRCA1 or BRCA2 — the prevalence is around 0.5%, far below the 46% in Mor's study population. Similar battles over the correct use of statistics litter the cancer-biomarker field, said researchers at the IOM meeting last year. "It's the type of thing where non-statisticians think statisticians are being uptight about something that's not going to matter anyway," says McShane.

Mor prepared a paper reporting the latest work. But when Feng and Longton saw the page proofs, they noticed that the PPV value was reported as 99.3%. They asked Mor to change it to the 6.5% that they had calculated, and to correct a few other typographical errors in the tables. "He agreed, so we signed off," recalls Feng. But there was a miscommunication: Mor thought that Feng had agreed to the use of the high PPV, and that everyone approved of the final manuscript.

The paper was published online in Clinical Cancer Research[6] in February 2008, and to Feng's shock it reported the high PPV. "You can imagine how upset I was when I saw it in the paper," says Feng.

Feng called Mor. "I told him, those are errors, we told you those are not correct." Feng also contacted the journal, the editor of which asked Mor to submit a correction to fix the PPV and the other typos. Mor agreed, adding the lower PPV as a footnote to the table and in a written correction.

A few weeks later, Feng received an e-mail with unwelcome news from a colleague: LabCorp was preparing to market the panel, and was "hopeful that this test will be available to women by the end of the year".

"I was shocked," says Feng. "I had no idea this was coming." He thought that the markers should be validated further before they went to the clinic. In March 2008, Feng and Mor saw each other at a meeting in Washington DC. "I told him, face to face, you cannot do this," says Feng. "You have to wait until after the PLCO validation. What you have done is early discovery. If validation does not support your earlier claim, you're making a significant error." Mor does not recall this encounter, but says that Feng's "role was to analyse the data, not to make judgements of a company decision".

Now, Mor says that if he were preparing the paper again, he would include both the low and high values for the PPV. And he vacillates about whether LabCorp's decision to offer the test to women before it had undergone more validation studies was the right thing to do. He says he thought that clinical use of the test might be a good way to do further validation. "It's very difficult to do that on large numbers of patients," he says. "It's extremely expensive. The only way to do the study is if LabCorp started distributing the test and enrolling patients." Mor notes that many tests, such as mammography, have been offered to patients as an aid to diagnosis even while data on the test are being collected. "Was it the right time? I don't know," he says.

Critical backlash

On 23 June 2008, LabCorp announced the availability of the OvaSure test, for between US$220 and $240. The press release said that it was being offered to women with a high risk of the disease, and quoted Mor as saying he was "pleased that this test is available to help physicians detect and treat ovarian cancer in its earliest stages".

Excited chatter about the test spread through patient forums and support groups, but it was soon countered by cautionary tales. Jean McKibben, an ovarian-cancer survivor, rushed to take OvaSure on the first day it was available, and her results showed a 0.00 chance of cancer. A week later, scans showed that her cancer was back. She was crushed. "I wanted this to work so badly," she wrote on a discussion board.

One week after LabCorp's announcement, the Society of Gynecologic Oncologists in Chicago, Illinois, released a statement expressing concern about OvaSure, saying that "additional research is needed to validate the test's effectiveness". The paper in Clinical Cancer Research was also circulating at the Canary Foundation,

a non-profit organization based in Palo Alto, California, that funds research on early cancer detection. Scientists there found other reasons for concern. One member, Nicole Urban, head of the Gynecologic Cancer Research Program at the FHCRC, had found that levels of prolactin, one of the proteins in the panel, are highly sensitive to stress — something very likely to affect women entering the clinic with symptoms of ovarian cancer[7]. After controlling for that, she says, "prolactin gave no signal at all for malignancy. It was useless." Others pointed out that the high specificity and sensitivity figures reported in the paper's conclusions, and trumpeted in Yale and OvaSure press releases, were not present in any of the tables or figures. And they bristled at the positive tone of the discussion, which stated that the test "will enhance the potential of treating ovarian cancer in its early stages and therefore, increases the successful treatment of the disease".

"There were a lot of uncertainties, and evidence of biases," says Martin McIntosh, who researches markers for early-stage ovarian cancer at the FHCRC, and is a member of the Canary group, "But the narrative only highlighted the best-performing analysis. It didn't mention caveats." Members of the Canary group wrote a letter to Clinical Cancer Research, describing some of their complaints. Meanwhile, Feng agreed to co-author a second letter, criticizing the paper even though he was a co-author.

The fuss was already reaching the FDA, which on 7 August 2008 sent a letter to LabCorp saying that the test "has not received adequate clinical validation, and may harm the public health". A second letter, sent by the FDA on 29 September 2008, alleged that LabCorp did not have the necessary marketing clearance or approval for the test from the FDA. LabCorp replied to the FDA on 20 October, disagreeing with the agency's assertions, but agreed to pull OvaSure from the market. It did so on 24 October 2008, just one day after Clinical Cancer Research published the critical letters from the Canary Foundation and Feng, as well as a third from the Centers for Disease Control and Prevention (CDC) in Atlanta, Georgia[8,9,10]. (Millipore continues to market the biomarker panel for use in research, not by patients.)

Mor was surprised by all three letters. In his published response[11], he disputed some of the criticisms and wrote that any concerns about commercialization should be taken up with LabCorp. Stephen Anderson, vice-president of investor relations at LabCorp, says that OvaSure was not marketed as a test for detecting cancer recurrence, which was how some patients used it. He says that LabCorp "continues to believe OvaSure offers a valuable tool for ovarian-cancer detection in conjunction with other diagnostic techniques", and that the assay is still in development. The company would not provide further comment.

Doubts and lessons

Since then, Mor has worked hard to validate his panel. He and Ward have completed a study on a much larger set of samples including many from women diagnosed in the earliest stages of ovarian cancer[12], and in which LabCorp again ran the assays. The test still performed well at distinguishing the patients from the healthy controls. Mor says he is puzzled by the PLCO trial results, and he hopes that further analysis of the trial data will help to explain why his biomarkers performed so poorly. He continues to express confidence in his panel, saying that the test could be most useful in high-risk populations, and when used regularly — every two to three months — to monitor rising and falling levels of the biomarkers. But the whole experience has made him reluctant to pursue biomarker work much further. "I'm focusing on understanding cancer stem cells," he says.

Others say that's just as well. The panel's poor performance in the PLCO study makes critics question its usefulness in any group, even a high-risk one. McIntosh says that the PLCO study's damning conclusions should serve as a wake-up call. "The entire field has to cope with this," he says — including him, given that the most promising biomarkers discovered by his institution also failed to improve on CA-125 in the trial. "It's hugely disappointing."

The IOM committee, which is expected to release its results sometime in 2012, may help to find a way forward. At a meeting later this month, the members plan to draw lessons from the biomarker failures, as well as from the few success stories (see 'The gene collection that could'). One of the most urgent lessons is the need to help researchers validate their biomarkers on appropriate samples before they reach the clinic. Feng says that the EDRN has been collecting its own high-quality tissue reference sets for ovarian, breast, lung, colon, liver and prostate cancers, from people who aren't yet showing symptoms and those in all stages of the disease. Investigators can apply to test their biomarkers on blinded tissue samples.

Until this type of testing becomes commonplace, there is no way of excluding the possibility that, as Hayes suggested at the IOM meeting, "these things just don't work" — particularly when it comes to picking up cancer early on.

"People keep talking about early-detection biomarkers as if they are a fact, and we only need to find them," says McIntosh,"when in reality their existence is a hypothesis that needs to be tested."

See Outlook p.450

Lizzie Buchen is a freelance writer in San Francisco, California.

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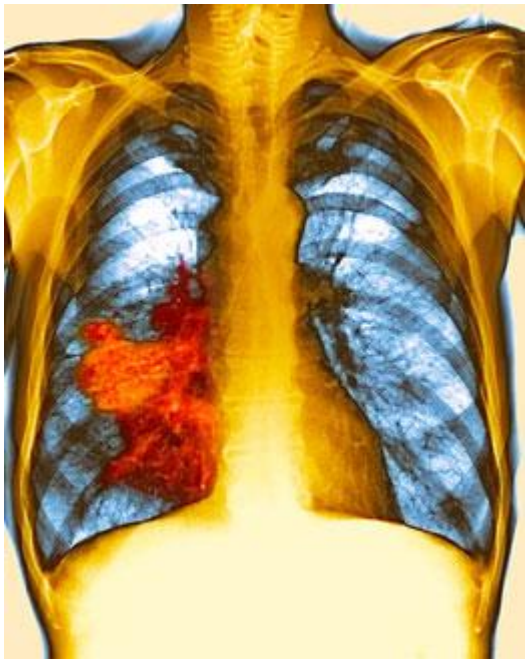
Mutations block lung-cancer treatment

Revealing the genetic changes that let tumours escape drugs offers hope for combination therapies.
Heidi Ledford



Lung cancers can resist drugs from the outset, or develop resistance over time.Du Cane Medical Imaging/Science Photo Library

Tumours have many ways to dodge drug therapies, even those that are genetically targeted to attack them, two studies published today reveal. By uncovering these escape routes, researchers hope that therapies can be tailored to cut them off.

Both studies focus on lung cancers with genetic mutations that activate a protein called epidermal growth factor receptor (EGFR). Improper activation of this protein can lead to uncontrolled cell division, a hallmark of cancer. Two drugs — gefitinib (Iressa) and erlotinib (Tarceva) — block EGFR in tumours with activating mutations to prevent tumour growth.

These drugs help most patients: about three quarters of those with EGFR-activating mutations respond well to gefitinib, for example. But the rest respond poorly, if at all, and no one knows why.

"There is tremendous variation in response in patients with what look to be the same lesions," says Charles Sawyers, a cancer researcher at the Memorial Sloan-Kettering Cancer Center in New York and lead author of one of the studies.

Resisting arrest

One cause of this variation, Sawyers reasoned, could be that other genes modify a patient's response to the drugs. To test this, he and his colleagues ran experiments on a line of cultured cancer cells with EGFR-activating mutations that respond poorly to EGFR inhibitors.

The researchers used RNA interference to reduce the activity of cancer-related genes, and then tested the cells to determine whether this made them more sensitive to drug treatment. The findings are published in Nature[1].

Of more than 2,000 genes screened by the team, 36 affected sensitivity to EGFR inhibitors. Half of those are linked to cellular signalling pathways involving a single protein called NF-κB, which governs many stress responses, and has been targeted by some pharmaceutical companies looking to develop anti-inflammatory drugs.

Sawyers's results suggest that NF-κB inhibitors, used in combination with EGFR blockers, could fight recalcitrant tumours. The team found clinical evidence to back this up: in a trial of 52 people with lung

cancer, those with high levels of a protein that inhibits NF-κB responded better to erlotinib than those with low levels.
The team is now testing the combination therapy in animal models.
The results are exciting and could lead to new cancer therapies, says William Pao, a cancer researcher at Vanderbilt University in Nashville, Tennessee.
The method could also be used to find genes that modify drug responses in other tumours, he says. For example, drugs called B-RAF inhibitors have shown promise in patients with advanced melanoma who carry a mutation that activates the protein B-RAF. But once again, the drug fails about 20% of these patients. Combination therapy could help that 20%.

Workarounds

Cancer therapies have another problem: even if a patient responds well at first, the drugs eventually fail. "The tumour melts away, and then it comes back," says Daniel Haber, director of the Massachusetts General Hospital Cancer Center in Charlestown.
The effects of EGFR inhibitors typically last a year before the tumours, now drug-resistant, return. Combination therapies could also help in this case, but it is first necessary to characterize the many ways that a tumour can shield itself from the drugs.
In the second study, Jeffrey Engelman, a cancer researcher at the Massachusetts General Hospital, and his team characterized resistant tumours in 37 patients.
Many had additional EGFR-related mutations, which allowed the protein to dodge inhibitors. Others had extra copies of the MET gene, which spurs cancer growth. Both of these mutations had already been identified in drug-resistant tumours.
But some tumours behaved unexpectedly, by amplifying the gene for EGFR or picking up mutations in another cancer-promoting gene, called PIK3CA. The results are published in Science Translational Medicine[2].
Five tumours had transformed from non-small-cell lung cancer to small-cell lung cancer, which is responsive to different kinds of chemotherapy. And in three patients, repeated biopsies showed that, over time, drug-resistant cells had once again become vulnerable to the inhibitors.

On target

The results highlight the importance of monitoring tumours throughout treatment, says Paul Workman, a molecular pharmacologist at the Institute of Cancer Research in Sutton, UK. Traditionally, cancer treatment is based on the results of a single biopsy during initial diagnosis. Sampling tumours is invasive, and repeated biopsies can be difficult to justify — particularly in lung cancer, when each biopsy carries a small risk of lung collapse, says Haber.
But Engelman points out that serial biopsies paid off for some patients. Those who developed small-cell lung cancer could receive chemotherapy that would not have been tried in a non-small-cell lung cancer. Some of those patients, he notes, had "remarkable" responses to the treatment.
Nevertheless, finding so many paths to drug resistance means that patients will need an arsenal of possible drug combinations to conquer the disease. "It is humbling to see the many resistance mechanisms that can occur," says Engelman. "It underscores the challenges ahead."

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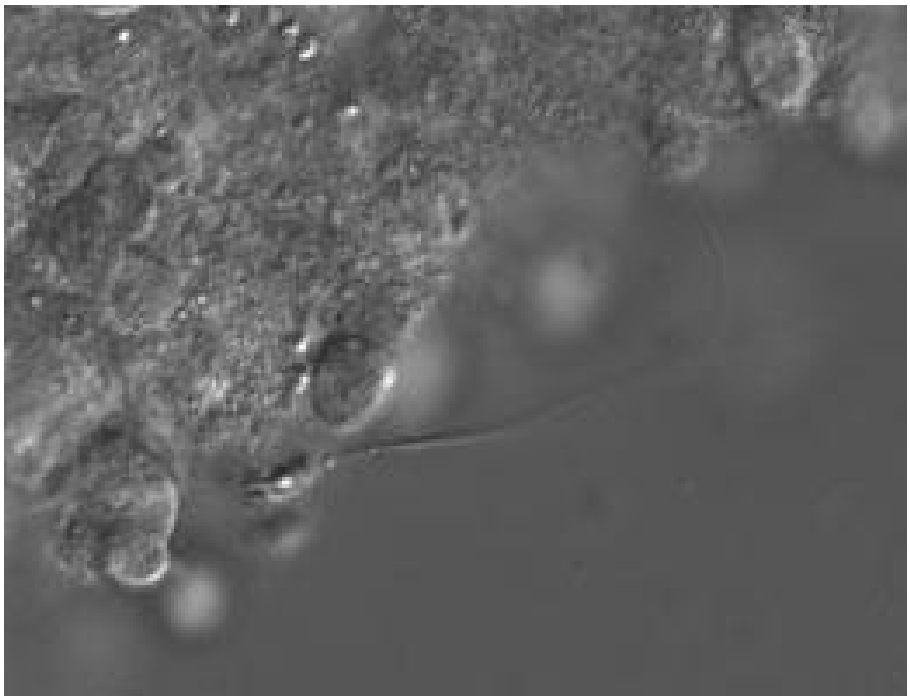
Sperm grown in a test tube

Immature mouse testicles yield fully developed sperm in culture.
Janelle Weaver



Biologists have sought to induce sperm formation in cell culture for decades.T. Ogawa

Researchers in Japan have made fertile mammalian sperm in a culture dish, a feat long thought to be impossible. The technique, reported today in Nature[1], could help to reveal the molecular steps involved in sperm formation and might even lead to treatments for male infertility.

Biologists have been trying to make sperm outside the body for almost a century. Failure has often struck at the stage of meiosis, a type of cell division during which paired chromosomes swap DNA and the number of chromosomes per cell is halved. The result of this process is sperm cells ready to fuse with an egg.

Takehiko Ogawa and colleagues at Yokohama City University discovered that the key to getting sperm through meiosis lay in a simple change to standard culture conditions.

"The report is quite exciting because it represents the fulfilment of a goal held by many reproductive biologists over many years," says Mary Ann Handel, an expert in reproductive genetics at the Jackson Laboratory in Bar Harbor, Maine.

Culture shock

By trial and error, Ogawa's team worked out which culture methods allowed sperm in tissue fragments from neonatal mouse testes to mature. To track sperm development, they used a fluorescent protein that marked cells undergoing — or that had undergone — meiosis.

Initially, the researchers placed the fragments on a gel and soaked them in fetal bovine serum, a typical ingredient of cell cultures. But nothing they added to this mix worked, not even factors known to stimulate sperm maturation.

The authors' success came when they replaced the fetal bovine serum with a serum-free medium, KnockOut Serum Replacement, which is often used to grow embryonic stem cells.

After several weeks of bathing in this mixture, almost all tissue samples contained some cells with the same number of chromosomes found in sperm. Nearly half of the samples contained cells with flagella, tail-like projections that sperm use to swim. Sperm formation peaked after about a month, although it lasted for more than two months.

The researchers injected the sperm into egg cells. A few weeks later, surrogates delivered a dozen live, fertile offspring. The team also grew sperm from neonatal testis tissue that had been frozen for days or weeks.

Matter of time

Ali Honaramooz, a reproductive biologist at the University of Saskatchewan in Saskatoon, Canada, says that the technique could aid prepubescent boys about to undergo cancer therapies that destroy fertility. It could also protect the reproductive potential of endangered animals that might die before reaching sexual maturity, he adds.

The procedure will also be useful for studying the molecular events that underlie sperm production, says Martin Dym, a cell biologist at Georgetown University in Washington DC. But before the technique can be used in treatments for male infertility, researchers will have to generate millions of sperm cells and translate the work to humans, Dym adds.

Honaramooz says that is just a matter of time. "If the same methodology can be applied, with many minor changes, to other species, that's great," He says. "If not, then it would take almost the same amount of work, but at least now you know that eventually it's going to work."

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Genome builders face the competition

Three independent projects seek to contrast approaches in preparation for routine analysis of genetic data.
Erika Check Hayden

Test case: researchers will evaluate programs assembling this bee's genome.D. WROBEL/VISUALS UNLIMITED/CORBIS

Sequencing DNA on an industrial scale is no longer difficult: the challenge is in assembling a full genome from the multitude of short, overlapping snippets that second-generation sequencing machines churn out. Researchers can call on any of two dozen computer programs to do the job, but all have their flaws. With genome sequencing fast becoming standard practice across the life sciences, researchers want to know how to choose.

The answer may come from three separate genome-assembly projects, each of which aims to test different algorithms on batches of raw sequence data and to compare the results.

There won't be any single 'winner', researchers stress. There is no consensus way to determine the absolute quality of a genome, and different assemblers might do a better job of handling different types of data.

"My dream is that a few years from now, a person who is about to do a genome project will be able to say, 'This is our budget, these are the characteristics of our genome; what is the combination of sequencing technologies and genome-assembly program that best fits our project?'" says Ian Korf at the University of California, Davis, who helped to organize the Assemblathon, one of the three genome-assembly evaluation projects.

Last December, the Assemblathon released a computer-generated human genome data set. Scientists were invited to use their assembler of choice to stitch the data into a genome. Seventeen teams from seven countries took up the challenge. Korf's team then evaluated the assemblies on the basis of commonly used criteria for the quality of genome assemblies — such as the portion of the genome that is assembled into large chunks of DNA, or contigs — as well as less-common measurements, such as how many genes each assembly is able to capture.

At a meeting last week at the University of California, Santa Cruz, three winners emerged: ALLPATHS-LG, developed by the Broad Institute in Cambridge, Massachusetts; ABySS, developed at the British Columbia Cancer Agency's Genome Sciences Centre in Vancouver, Canada; and SOAPdenovo, developed by the Beijing Genomics Institute. But, Korf notes, "it's not just the software, it's how people are running it" that determines the quality of each assembly.

A similar genome-assembly project called dnGASP has been organized by the National Center for Genome Analysis in Barcelona, Spain. Its results are set to be discussed at a workshop on 4–7 April.

A third project, led by Steven Salzberg of the University of Maryland, College Park, is evaluating just five assemblers, among them ALLPATHS-LG and SOAPdenovo. Salzberg's group will perform and evaluate all the assemblies. In addition, the researchers will use real genome data from four species, including the Argentine ant and the common eastern bumblebee. "With purely simulated data, you don't get a realistic picture of how these assemblers perform," says Salzberg.

Later this year, the Assemblathon will launch another round of evaluation, comparing efforts to assemble two previously unreleased genomes, that of a parrot and a cichlid fish. And although the three current efforts are

focused on data generated by the popular Illumina sequencers, new sequencing methods could become commercially available as early as next year.
Their output will differ from that of the Illumina machines; the single molecule, real-time (SMRT) technology developed by Pacific Biosciences of Menlo Park, California, for instance, produces longer reads but has higher error rates (see Nature **470,** 155; 2011). This creates a new challenge, says Gene Robinson, an entomologist at the University of Illinois at Urbana-Champaign, whose bee sequence data are being used by the University of Maryland project. "Biologists really want assembly algorithms that can make use of multiple forms of reads and build the best possible assembly," Robinson says.
The contest is just beginning.

http://www.nature.com/news/2011/110323/full/471425a.html

Radiation risks unknown

Scientists struggle to calculate long-term effects of low-dose exposures in Fukushima.
Gwyneth Dickey Zakaib

A farmer destroys spinach in Ibaraki prefecture after it was contaminated by radioactive iodine.The Asahi Shimbun via Getty

One thing is certain about the human costs of the radiation leaking from the Fukushima Daiichi nuclear plant in Japan: they will pale in comparison to the catastrophic consequences of the 11 March earthquake and tsunami that triggered the crisis. Nevertheless, experts are tracking radiation levels worldwide to learn more about the accident and to assess the possible impacts on health.

Radioactive vapour and particles released from the plant have spread across the region and followed prevailing winds across the Pacific (see 'Plume projections'). "The plume is very large," says Ted Bowyer, a nuclear physicist at the Pacific Northwest National Laboratory in Richland, Washington, one of the first US stations to detect isotopes released from Fukushima. Bowyer adds that the tiny concentrations of radioactive iodine, caesium, tellurium, xenon and lanthanum that have reached the United States are far below normal background levels and not a health risk. The fact that some of the isotopes are short-lived indicates that at least some of the radiation must have originated from breaches in the reactor vessels and not from the plant's overheated caches of spent fuel, he says.

In Fukushima and adjacent prefectures, the Japanese government is reporting radioactive contamination in sea water near the plant and in the food and water supply. Radioactive iodine-131 and caesium-137 have been detected in milk and leafy vegetables such as spinach, as well as in tap water, in some cases above allowable levels for consumption. Such safety limits are based on long-term consumption of these foods, says William McCarthy, deputy director of the radiation protection programme within the Environment, Health and Safety Office at the Massachusetts Institute of Technology (MIT) in Cambridge. "The prudent thing is to not eat that food," he says. "That doesn't mean it poses immediate health risks."

Authorities in Japan have banned the shipment of milk from Fukushima prefecture, as well as some produce from Fukushima and three neighbouring prefectures. In the short term, the main concern is iodine-131, which

can cause cancer in the thyroid gland. With a half life of 8 days, iodine-131 will effectively be gone from the environment in a matter of months once releases have stopped. But caesium-137, another cancer-causing isotope, has a half-life of 30 years and will persist for much longer. Steve Wing, an epidemiologist from the University of North Carolina, Chapel Hill, points out that even the low levels of radiation that remain in the environment could be significant in the long run "because so many more people are exposed, even though the dose per person decreases farther from the plant".

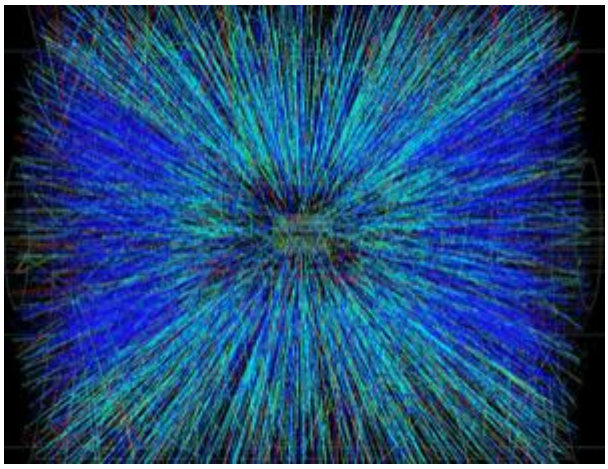
Jacquelyn Yanch, a radiation physicist at MIT, thinks that it is too early to say what the impact will be. "We haven't come up with risk estimates for a situation like this," she says. "We don't know how much is too much."

Experts agree that any long-term effects are most likely to be seen in the workers battling the crisis at the Fukushima nuclear station. The government has increased the allowable dose for workers from 100 millisieverts per year to 250 millisieverts per year — five times the annual allowable dose for US radiation workers — to allow emergency operations to continue. This dose is considered by the US National Institutes of Health as the lower limit for the first symptoms of radiation sickness.

http://www.nature.com/news/2011/110322/full/471419a.html

Physicists create heaviest form of antimatter ever seen

- 19:58 22 March 2011 by **Stephen Battersby**



Smashing time (Image: STAR/RHIC)

A newly created form of antimatter is the heaviest and most complex anti-thing ever seen. Anti-helium nuclei, each containing two anti-protons and two anti-neutrons, have been created and detected at the Relativistic Heavy Ion Collider (RHIC) in Upton, New York.

Anti-particles have the opposite electrical charge to ordinary matter particles (anti-neutrons, which are electrically neutral, are made up of antiquarks that have the opposite charge to their normal quark counterparts). They annihilate on contact with matter, making them notoriously tricky to find and work with. Until recently, the most complex unit of antimatter ever seen was the counterpart of the helium-3 nucleus, which contains two protons and one neutron.

But experiments at RHIC are changing that. RHIC collides heavy atomic nuclei such as lead and gold to form microscopic fireballs, where energy is so densely packed that many new particles can be created.

Last year RHIC announced the creation of a new variety of antimatter. Called the anti-hypertriton, it is made of one anti-proton, one anti-neutron and one unstable particle called an anti-lambda. The anti-hypertriton was then the heaviest antiparticle known, but the 18 nuclei of anti-helium-4 seen at RHIC now takes the record.

Anti-periodic table

"They have moved us up to the next element in the anti-periodic table," says Frank Close of the University of Oxford in the UK.

But he adds, "It doesn't take us nearer to the big question of why is the universe at large not full of antimatter?" Indeed, standard theories say that matter and antimatter were created in equal amounts in the universe's first instants, but for unknown reasons, matter prevailed.

An experiment called the Alpha Magnetic Spectrometer, due to launch to the International Space Station in April, will try to chip away at the problem. Anti-protons are known to occur naturally in small quantities among the high-energy particles called cosmic rays that hit Earth.

The AMS will search for heavier anti-particles. But if anti-helium is produced only rarely in collisions, as shown by RHIC, then the AMS should see no anti-helium. If it finds higher levels of anti-helium, that could bolster a theory that antimatter was not all destroyed in the early universe but merely separated in a different part of space, where it would not come into contact with matter.

The next heaviest anti-element, anti-lithium, could in theory form solid antimatter at room temperature – but it will be much harder to make. The RHIC team calculates that it will occur in their collisions less than one-millionth as often as anti-helium, putting it beyond the reach of today's colliders.

Journal reference: arxiv.org/abs/1103.3312

http://www.newscientist.com/article/dn20274-physicists-create-heaviest-form-of-antimatter-ever-seen.html?full=true&print=true

Dark energy is not an illusion after all

- 15:54 16 March 2011 by **David Shiga**

New measurements of exploding stars are challenging an upstart theory that dark energy is just an illusion caused by our location within a giant void.

In 1998, astronomers reported that the universe's expansion seems to be faster now than it was in the past, based on measurements of supernova explosions in both nearby and distant galaxies. The latter provide a record of the past because of the time it takes their light to reach us.

That the universe's expansion could be accelerating was a surprise, since gravity should act as a brake on the expansion, slowing it with time. The most popular explanation is that energy of unknown origin – called dark energy – permeates space and acts as a repulsive force to speed up the expansion.

But some researchers have proposed an alternative: that the acceleration is an illusion that results from an uneven distribution of matter in the universe.

Dark pedal

They accept that the expansion rate in the local universe is higher than in more distant regions. But instead of assuming the expansion rate has increased with time, they suggest our patch of the universe happens to contain less matter than average. Within this "void", the expansion rate is higher than outside because there is less gravity to slow it down.

But new, more precise measurements of supernovae, taken by the Hubble Space Telescope, clash with the simplest version of the void model. That model could be made to fit previous supernova measurements and other cosmological data, but only if the local expansion rate is about 60 kilometres per second per megaparsec or less. (One megaparsec is 3.26 million light years.)

That was within the possible error of previous measurements, but the new, more precise measurements give an expansion rate of 74 kilometres per second per megaparsec, plus or minus 2.4.

"It looks more like it's dark energy that's pressing the gas pedal," says Adam Riess of Johns Hopkins University in Baltimore, Maryland, who led the observations. The results appear in *The Astrophysical Journal*.

Void within a void?

But Subir Sarkar of the University of Oxford, a proponent of the void theory who was not involved in Riess's study, says the results are not a fatal blow. "The observers have done a good job, but it should be kept in mind that there is some flexibility in the alternative models, which can in fact accommodate higher values" for the local expansion, he says.

He points to a study by Tirthabir Biswas of Saint Cloud State University in Minnesota and colleagues, published in November in the *Journal of Cosmology and Astroparticle Physics*, which tested a variety of void

models against astronomical data. Some of them allow local expansion rates as high as the new Hubble value by positing a "void within a void", where the density of matter is not constant within the void itself, but drops off steeply towards its centre.
Although such a model might seem contrived, the alternative is to invoke dark energy, whose origin is very hard to explain, says Sarkar. "I would rather believe that the universe is a little more complicated than the standard cosmological model assumes it to be," he says.
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AI lie detection could help crack terror cells

- 14 March 2011 by **Anil Ananthaswamy**
- Magazine issue 2803.

Skin signals give the game away (Image: MAST IRHAM/EPA/CORBIS)

IN A bar in Maastricht University in the Netherlands, 12 students are each given an envelope marked "Top Secret". Inside are plans for a terror attack somewhere in the country. They must tell no one.

Later, the students are arrested under suspicion of terrorist activities and interrogated using a so-called concealed information test (CIT). Sensors measure skin conductance - moisture levels in their skin. Then mathematical techniques borrowed from artificial intelligence analyse the findings to work out what the students are hiding.

This was of course a mock-up - an experiment carried out in a psychology lab at Maastricht University. But the idea was to show that the new test could one day surpass existing lie detection techniques in ferreting out information from groups of suspects. Traditional lie detectors concentrate on individuals, whereas a group CIT is able to uncover a single piece of information that is being concealed by the entire group, for example, the name of a target city.

Ewout Meijer, who led the experiment, says that many of today's security threats are from terrorist groups involving multiple suspects.

Lie detection techniques usually compare a suspect's responses to a series of questions about a crime against responses to innocuous questions. These responses are recorded via a polygraph, which measures physiological signals, including pulse, respiration rate and skin conductance. But this method is considered unreliable.

Instead, Meijer used a CIT where the aim is to see if a suspect reacts strongly to any particular question in a series of similar ones. In the mock-up, Meijer's team questioned the 12 students while measuring their skin conductance by attaching two small electrodes to their fingers. The students were presented with a battery of queries that listed possible cities, dates, and specific targets for the planned attack, including the correct information for each. They were told to answer "no" to all the questions.

If the suspect is guilty, a question that identifies an element of the plot will elicit an autonomic nervous system response - an arousal response - which is stronger than for other questions in the series. This triggers a spike in both skin conductance and an EEG signal called P300, though this wasn't measured here (see "EEG signals flag up meaning"). An innocent person's physiological responses will trigger no such spikes.

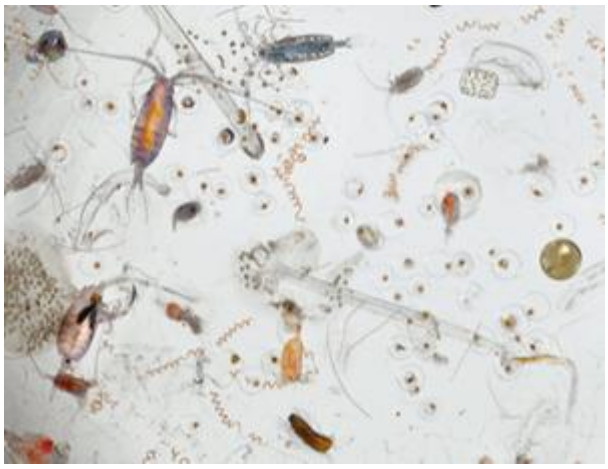
Results from the skin conductance tests were analysed by software containing Bayesian networks, mathematical models that deal with probability, which are the bedrock of artificial intelligence. By comparing the data with the patterns of responses you would expect to find in guilty and innocent subjects, the software determined with high probability that all the suspects knew the attack was planned for 15 August in a particular department store in Rotterdam - the correct answer (*Journal of Forensic Sciences*, DOI: 10.1111/j.1556-4029.2010.01474.x).

Whether this will translate to real-world terror situations is another matter as analysis is made far more difficult if individuals in a group possess only fragments of information about a planned attack, Meijer admits.
Still, Frank Horvath of Michigan State University in East Lansing, says the technique could be useful for fighting terrorism. "It won't necessitate tactics that we are all familiar with and find distasteful, if not worse," he says.

http://www.newscientist.com/article/mg20928034.900-ai-lie-detection-could-help-crack-terror-cells.html?full=true&print=true

Biology's 'dark matter' hints at fourth domain of life

- 21:00 18 March 2011 by **Colin Barras**



Is there a new branch of life in that lot? (Image: David Liittschwager/NGS)

Step far enough back from the tree of life and it begins to look quite simple. At its heart are just three stout branches, representing the three domains of life: bacteria, archaea and eukaryotes. But that's too simple, according to a band of biologists who believe we may be on the verge of discovering the fourth domain of life.

The bold statement is the result of an analysis of water samples collected from the world's seas. Jonathan Eisen at the University of California, Davis, Genome Center has identified gene sequences hidden within these samples that are so unusual they seem to have come from organisms that are only distantly related to cellular life as we know it. So distantly related, in fact, that they may belong to an organism that sits in an entirely new domain.

Most species on the planet look like tiny single cells, and to work out where they fit on the tree of life biologists need to be able to grow them in the lab. Colonies like this give them enough DNA to run their genetic analyses. The problem is, the vast majority of these species – 99 per cent of them is a reasonable bet – refuse to be cultured in this way. "They really are the dark matter of the biological universe," says Eisen.

Life's dark matter

To probe life's dark matter, Eisen, Craig Venter of the J. Craig Venter Institute in Rockville, Maryland, and their colleagues have resorted to a relatively new technique called metagenomics. This can "sequence the crap out of any DNA samples", whether they are collected from the environment or come from lab cultures, says Eisen.

When Eisen and Venter used the technique on samples collected from the Global Ocean Sampling Expedition, they found that some sequences belonging to two superfamilies of genes – *recA* and *rpoB* – were unlike any seen before.

"The question is, what are they from?" says Eisen. Because the team has no idea what organism the genes belong to, the question remains unanswered. There are two possibilities, he says. "They could represent an unusual virus, which is interesting enough. More interestingly still, they could represent a totally new branch in the tree of life."

The exciting but controversial idea has met with mixed reactions. "It's a very good piece of careful work," says Eugene Koonin at the National Center for Biotechnology Information in Bethesda, Maryland.

Younger than they look?

But Koonin and others think any talk of a fourth domain of cellular life is premature. Radhey Gupta at McMaster University in Hamilton, Ontario, Canada, calls the finding "very exciting", but cautions that there are other explanations.

For instance, the sequences could be from cellular organisms living in unique habitats that caused their genes to undergo rapid evolution. That would give the false impression that the "new" life forms diverged from all others a very long time ago.
"There is still debate [over] how to clearly distinguish the three proposed domains of life, and how they are interrelated," Gupta says. "The suggestion [of] a fourth domain will only add to the confusion."
Eric Bapteste at Pierre and Marie Curie University in Paris, France, is far more receptive. "The facts are that there is lots of genetic diversity, and unquestionably most of it is unknown to us," he says. "It's legitimate to consider that there's genuinely new stuff out there."
Further analysis of the samples could determine whether the two gene families studied have evolved unusually rapidly or are from a cellular organism with a universally bizarre genome, he says.

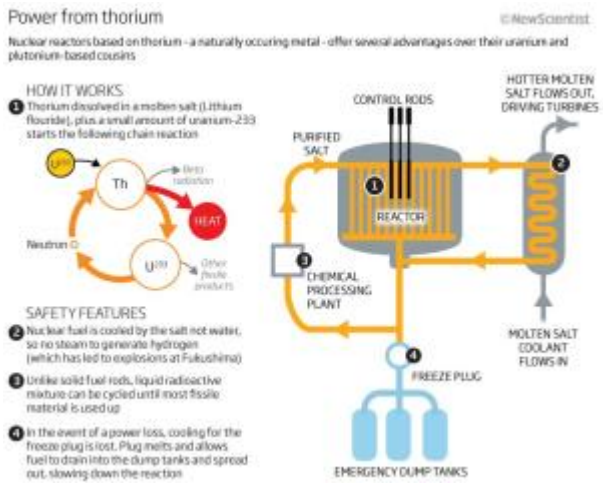
Parent organism

Looking at the actual samples could also help pin down exactly which organism the strange genetic sequences belong to, says Eisen.
If Eisen's gene sequences did turn out to belong to a new domain of life, it wouldn't be the first time the tree of life has had to be redrawn. Until the 1990s, it had just two branches: one for eukaryotes – animals, plants, fungi and some other strange forms, including the slime moulds – and one for everything else. Then, gene analysis revealed that the "everything else" branch could be divided into two domains: bacteria and archaea.
Not only that, some believe that mimivirus, the largest known virus, may also represent a new domain of life: despite being recognised as a virus, it contains many genes found only in cellular organisms. "People have suggested they might be a fourth branch themselves," says Eisen. "If you think of those mimiviruses as a fourth branch, maybe our sequences represent a fifth branch – we just don't know yet."
Journal reference: *PLoS One*, DOI: 10.1371/journal.pone.0018011

http://www.newscientist.com/article/dn20265-biologys-dark-matter-hints-at-fourth-domain-of-life.html?full=true&print=true

Thorium reactors could rescue nuclear power

- 23 March 2011 by **David Shiga**
- Magazine issue 2805.



Power from thorium
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Read more: "Special report: Rescuing nuclear power"
An alternative to conventional uranium and plutonium reactors would be immune to the problems that have plagued the Fukushima nuclear power plant
Editorial: "Cut nuclear power's umbilical cord to the military"
"IT IS not difficult to conceive of an entire planet powered by thorium," wrote Kirk Sorensen on his blog Energy From Thorium in 2006. Some would contest this bold claim, but given the crisis at the Fukushima Daiichi nuclear power plant in Japan, the energy source Sorensen advocates has been thrust into the spotlight.
Sorenson and others propose building reactors that use a naturally occurring element called thorium as the main starting material, instead of uranium or plutonium. Though the technology is far from fully developed and very different to conventional plants based on solid uranium and plutonium fuel, advocates say it would be immune to the problems that have plagued the Fukushima reactors and should produce less radioactive waste than conventional reactors.
"It has some really compelling safety advantages," says Sorensen, who is now chief nuclear technologist at the firm Teledyne Brown Engineering in Huntsville, Alabama.
He is not alone in his passion for thorium, which is globally much more abundant than uranium-235, the fuel used in conventional uranium reactors.
For some, nuclear energy, in particular thorium, is the best way to fight climate change. "We have got to stop using carbon fuels," says Roger Barlow, a particle physicist at the University of Manchester, UK. "I don't think unfortunately that renewables will provide the energy we need."
Still, thorium is just one of many possible ways of improving the safety of nuclear power plants (see "How newer reactors would have survived Fukushima"). Thorium reactors also present unique challenges that must be overcome before a working version could become reality. And that's without considering the cost of a switchover.
At the heart of a liquid fluoride thorium reactor (LFTR) is a chamber filled with thorium dissolved in a molten salt such as lithium fluoride at several hundred degrees Celsius. Thorium itself is barely radioactive, so a small amount of uranium-233 is added to kick-start nuclear reactions. Like U-235, it is radioactive and so fissions, releasing heat as well as neutrons. These hit thorium atoms, transforming them into more U-233 and producing heat in the process. The U-233 in turn fissions to produce more neutrons (see diagram). "It is a continual process of turning thorium into U-233, burning it up and generating new U-233," says Sorensen.

The fuel cools as it passes through a heat exchanger containing more molten salt, and this heated salt can then be used to drive turbines and generate electricity.
Without water as a coolant, there is a much lower risk of explosions. At Fukushima, these were caused by the build-up of steam and the generation of hydrogen by the breakdown of water.
A liquid fuel also reduces the volume of radioactive waste. In conventional uranium reactors, the solid fuel rods have to be removed from the core long before their radioactive waste products have decayed and the uranium fuel has been used up. That's because too much radiation makes the fuel rods swell and crack, allowing radiation to leak out.
By contrast, the fuel in a liquid reactor is unaffected by radiation and so can continue to be used until virtually all its radioactive components have undergone further reactions, or decayed into non-radioactive waste products.
Another advantage is that, unlike conventional solid fuel rods, fluoride salts are not flammable. If solid rods catch fire they release plumes of radioactive smoke.
The difficulty with fluoride salts, though, is that they are highly corrosive, so special materials are needed to contain them. An experimental molten salt reactor that ran from 1965 to 1969 at Oak Ridge National Laboratory in Tennessee used a corrosion-resistent nickel-molybdenum alloy called Hastelloy N as a container material. But even this had degraded by the end of the project.
Also, athough LFTRs would burn up most of the waste they produce, they would not eliminate every trace. Safe storage for some long-lived radioactive material would still be needed.
Pavel Tsvetkov, a nuclear engineer at Texas A&M University in College Station, points out that many of the claimed safety advantages of LFTRs must still be proved in more detailed studies. "Safety research is yet to be done," he says.
In December 2010, Europe's atomic energy agency Euratom committed to funding a €1 million study called EVOL. It will start with experiments and calculations involving liquid fluoride salts. "We have to first prove it's possible to handle that [material]," says Elsa Merle-Lucotte of the Laboratory of Subatomic Physics and Cosmology in Grenoble, France, one of the institutions involved in the project.
The aim of the study, which will run until November 2013, is to lay the groundwork needed before an LFTR can be designed. The project's participants then hope to win funding for a prototype. "Our dream is to build a demonstrator," says Merle-Lucotte.
Other countries are working on thorium energy, too. In January, the Chinese Academy of Sciences announced funding to develop a molten salt thorium reactor as part of a broader plan for science and technology development called Innovation 2020.
India has long experimented with thorium fuel, though in solid form. Though this lacks many of the advantages of the LFTR, India is keen to find ways to use thorium in conventional nuclear reactors as the country has abundant deposits of the metal and a scarcity of uranium.
Sorensen says he thinks the benefits of LFTRs will spur technology start-ups to invest in developing it, even if the established nuclear companies are reluctant because it is so different from what they know. "When you look at the individual technologies that go into a fluoride reactor they're totally different to what we use today," he says. "I think it's going to be new entrepreneurial companies that make this happen."

http://www.newscientist.com/article/mg20928053.500-thorium-reactors-could-rescue-nuclear-power.html?full=true&print=true

CT scans help recreate sniper attack

- 22 March 2011 by **Nic Fleming**
- Magazine issue 2804.

Where's the bullet? (Image: Adam Ferguson/VII Network/Corbis)

Knowing a bullet's path in the body could help doctors treat people with gunshot wounds in the field

A SINGLE muffled shot and a soldier is down. Some of his comrades grab him and run for cover, while others scan the buildings, trying to work out where the sniper is hiding.

A single sniper can cause havoc, which is why a lot of effort has gone into developing technologies to detect a sniper's location and potentially hit back before they strike. Medical researchers are also working on ways to calculate the path a bullet takes through the body, to enable doctors to treat victims more effectively.

There is currently no standard method of determining a bullet or bomb fragment's path through flesh and bone - doctors generally have to rely on visual cues. To try to produce a more quantifiable method, Les Folio, then at the Uniformed Services University in Bethesda, Maryland, and colleagues, asked a marksman to shoot six shots from a rifle at a distance of 45 metres into each of two model legs. These were composed of various densities of rubber and plastic to simulate soft tissue and bone (*Radiology*, DOI: 10.1148/radiol.10100534).

The researchers tilted the simulated limbs at six angles between shots, and then imaged them using high-resolution computed tomography (CT). Three radiologists independently estimated the trajectories of the bullets and the shooting angle using two methods. In one, they plotted the entrance and exit sites using coordinates taken from the scans and used these to calculate the angle. The other technique involved using software that allowed them to draw the estimated trajectory within the limb onto the on-screen image. Their estimates were all within 5 degrees of the actual shooting angles. Most were within 3 degrees.

This shows that CT-based methods can accurately determine a bullet's trajectory, Folio says. This will help doctors decide how to treat injuries and which patients to prioritise. Knowledge of the shooting angle could also be used to pinpoint a sniper's location, and to determine the identity of the shooter in military investigations involving "friendly fire" incidents, when video footage or eyewitnesses are unavailable.

Paul Hazell of the Defence Academy of the UK in Shrivenham, Oxfordshire, says the usefulness of the technique depends on where the victim is shot, because bone can make a bullet deviate. "The bullet might also swerve before it gets to the body because of turbulence, friction and other forces acting upon it," he says.

The technology for sniper detection systems is slightly further forward. The Boomerang system, developed in response to sniper threats to US soldiers in Iraq and Afghanistan, uses a seven-microphone array mounted at the rear of military vehicles. This detects the muzzle blast, the shock wave generated by incoming bullets and the difference in timing between the two, which is used to triangulate the position and elevation of the sniper within 1 second. The system then alerts nearby soldiers. The US army has deployed some 8000 Boomerang III units in Iraq and Afghanistan. A version called Warrior-X has also been developed for foot soldiers.

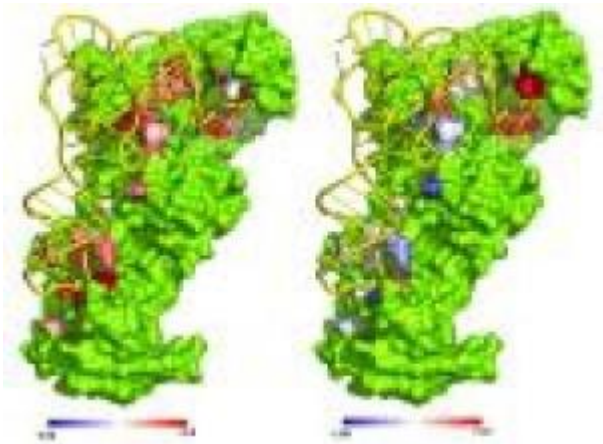
Boomerang has also been coupled with a well-established long-range surveillance system called LRAS3. This uses an infrared sensor, a GPS laser rangefinder - that uses lasers to calculate distance - and a video camera to

find a sniper's position using the signal from Boomerang. It then sends the information to units close by, reducing the time taken to return fire.
The obvious problem with such acoustic-based systems is that they rely on a shot already having been fired. The SLD500, made by French company CILAS and currently at the testing stage, uses laser scanning to detect the optical sights or goggles used by snipers to try to pinpoint them before they strike. It indicates the GPS position of possible snipers and can be coupled with thermal and video cameras, movement sensors and acoustic detectors to help confirm their identities.

- From issue 2804 of New Scientist magazine, page 26.

http://www.newscientist.com/article/mg20928044.800-ct-scans-help-recreate-sniper-attack.html?full=true&print=true

Glimpse of How the 'Code' of Life May Have Emerged



Crystal structure of glutaminyl tRNA synthetase (GlnRS, green) in complex with its substrate tRNA^Gln (yellow). Left panel: Color-coded residues depict favorable (blue) and unfavorable (red) effects on the free energy of glutamine binding from mutation at this position. Right panel: Effects of mutation on the ability of GlnRS to catalyze amino acid attachment to the tRNA. In this case all effects are unfavorable. (Credit: Annia Rodriguez/ John Perona / UCSB)

ScienceDaily (Mar. 23, 2011) — A portion of the "code" of life has been unraveled by a UC Santa Barbara graduate student from the town of Jojutla, Mexico. Annia Rodriguez worked with John Perona, professor in UCSB's Department of Chemistry and Biochemistry, to decipher intramolecular communication within a large RNA-protein enzyme responsible for expressing the genetic code for the amino acid glutamine. To their surprise, the experiments by Rodriguez captured a partial glimpse of how the genetic coding of life may have emerged.

The results of the study are published in the journal *Structure*.

Life is based on the ability of all living cells to convert the genetic information in DNA, into the specific sequences of amino acids that make up the proteins that are the cell's workhorses. The key reaction in this decoding process is the attachment of a particular amino acid to one end of a small RNA molecule known as a transfer RNA. The enzyme that catalyzes this amino acid-RNA attachment is the aminoacyl-tRNA synthetase.

Rodriguez performed many laborious experiments in which she removed portions of the aminoacyl-tRNA synthetase that interact with the anticodon stem of the transfer RNA, far from the part of the enzyme that binds the amino acid. Using a biochemical approach known as rapid chemical quench kinetics, Rodriguez discovered that when she made these changes to the enzyme, the binding of the amino acid to the protein was strengthened, even though the amino acid binds far away from the positions where the changes were made.

"It is totally counterintuitive," said Perona. "Imagine if you had a car, and you took out a gear, and the car went faster. Why would you want that gear if it makes your car go slower?"

In all, Rodriguez found that separately removing seven different "gears" from a distant part of the molecule each caused the amino acid to bind more tightly to the aminoacyl-tRNA synthetase. Perona explained that this provides the first systematic analysis demonstrating long-range communication in an enzyme that depends on RNA for its function.

"So what we think is going on is that these enzyme-RNA interactions far from the amino acid binding site evolved together with the needs of the cell to respond to subtle cues from its environment -- especially in terms of how much amino acid is available," said Perona. "It makes sense in terms of evolution."

Rodriguez is the first in her family to pursue a Ph.D., which she will complete this year. Now 28 years old, she began her career as a nurse in Cuernavaca, Mexico. Then she went on to obtain a B.S. in biochemical engineering at the Instituto Tecnológico de Zacatepec.

Graduation from her undergraduate program called for work at a research institution and she chose UCSB. Although her current research is not focused specifically on human health, Rodriguez said: "My interest in biochemistry started because I wanted to know the mechanisms by which drugs and medications worked

inside the human body. I wanted to learn not just the signs and symptoms of disease, but how diseases are developed in a molecular level."

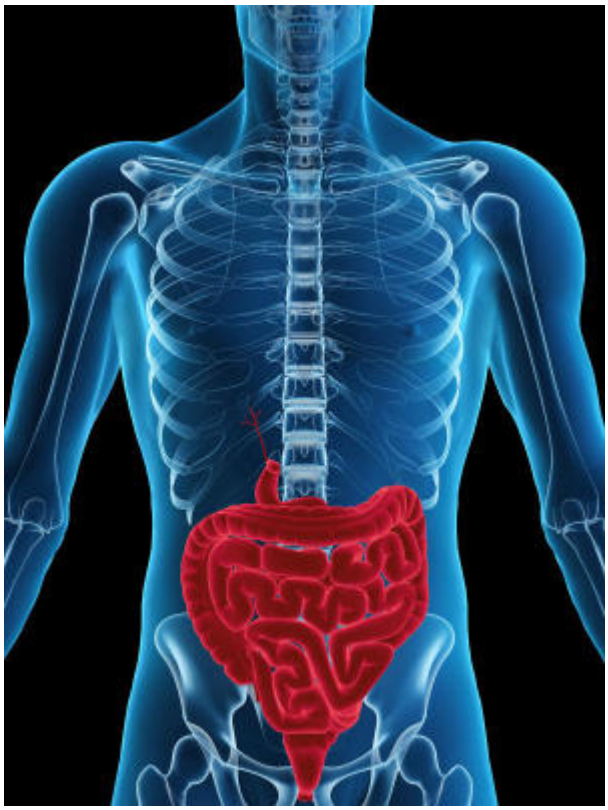
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of California - Santa Barbara**.

Journal Reference:

1. Annia Rodríguez-Hernández, John J. Perona. **Heat Maps for Intramolecular Communication in an RNP Enzyme Encoding Glutamine**. *Structure*, 2011; 19 (3): 386 DOI: 10.1016/j.str.2010.12.017

http://www.sciencedaily.com/releases/2011/03/110323140243.htm

'Knowing It in Your Gut': Cross-Talk Between Human Gut Bacteria and Brain



Gut bacteria influence anxiety-like behavior through alterations in the way the brain is wired, new research suggests. (Credit: iStockphoto/Mads Abildgaard)

ScienceDaily (Mar. 23, 2011) — A lot of chatter goes on inside each one of us and not all of it happens between our ears. Researchers at McMaster University discovered that the "cross-talk" between bacteria in our gut and our brain plays an important role in the development of psychiatric illness, intestinal diseases and probably other health problems as well including obesity.

"The wave of the future is full of opportunity as we think about how microbiota or bacteria influence the brain and how the bi-directional communication of the body and the brain influence metabolic disorders, such as obesity and diabetes," says Jane Foster, associate professor in the Department of Psychiatry and Behavioural Neurosciences of the Michael G. DeGroote School of Medicine.

Using germ-free mice, Foster's research shows gut bacteria influences how the brain is wired for learning and memory. The research paper has been published in the March issue of the science journal *Neurogastroenterology and Motility*.

The study's results show that genes linked to learning and memory are altered in germ-free mice and, in particular, they are altered in one of the key brain regions for learning and memory -- the hippocampus.

"The take-home message is that gut bacteria influences anxiety-like behavior through alterations in the way the brain is wired," said Foster.

Foster's laboratory is located in the Brain-Body Institute, a joint research initiative of McMaster University and St. Joseph's Healthcare in Hamilton. The institute was created to advance understanding of the relationship between the brain, nervous system and bodily disorders.

"We have a hypothesis in my lab that the state of your immune system and your gut bacteria -- which are in constant communication -- influences your personality," Foster said.

She said psychiatrists, in particular, are interested in her research because of the problems of side effects with current drug therapy.

"The idea behind this research is to see if it's possible to develop new therapies which could target the body, free of complications related to getting into the brain," Foster said. "We need novel targets that take a different approach than what is currently on the market for psychiatric illness. Those targets could be the immune system, your gut function…we could even use the body to screen patients to say what drugs might work better in their brain."

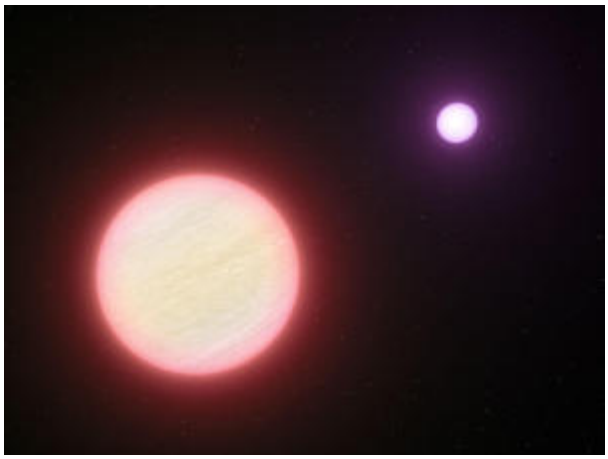
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **McMaster University**, via EurekAlert!, a service of AAAS.

Journal Reference:

1. K. M. Neufeld, N. Kang, J. Bienenstock, J. A. Foster. **Reduced anxiety-like behavior and central neurochemical change in germ-free mice**. *Neurogastroenterology & Motility*, 2011; 23 (3): 255 DOI: 10.1111/j.1365-2982.2010.01620.x

http://www.sciencedaily.com/releases/2011/03/110323140247.htm

Coldest Known Star: Brown Dwarf About as Hot as a Cup of Tea



This artist's impression shows the pair of brown dwarfs named CFBDSIR 1458+10. Observations with ESO's Very Large Telescope and two other telescopes have shown that this pair is the coolest pair of brown dwarfs found so far. The colder of the two components (shown in the background) is a candidate for the brown dwarf with the lowest temperature ever found — the surface temperature is similar to that of a cup of freshly made tea. The two components are both about the same size as the planet Jupiter. (Credit: ESO/L. Calçada)

ScienceDaily (Mar. 23, 2011) — Brown dwarfs are essentially failed stars: they lack enough mass for gravity to trigger the nuclear reactions that make stars shine. The newly discovered brown dwarf, identified as CFBDSIR 1458+10B, is the dimmer member of a binary brown dwarf system located just 75 light-years from Earth [1].

The powerful X-shooter spectrograph on ESO's Very Large Telescope (VLT) was used to show that the composite object was very cool by brown dwarf standards. "We were very excited to see that this object had such a low temperature, but we couldn't have guessed that it would turn out to be a double system and have an even more interesting, even colder component," said Philippe Delorme of the Institut de planétologie et d'astrophysique de Grenoble (CNRS/Université Joseph Fourier), a co-author of the paper. CFBDSIR 1458+10 is the coolest brown dwarf binary found to date.

The dimmer of the two dwarfs has now been found to have a temperature of about 100 degrees Celsius -- the boiling point of water, and not much different from the temperature inside a sauna [2]. "At such temperatures we expect the brown dwarf to have properties that are different from previously known brown dwarfs and much closer to those of giant exoplanets -- it could even have water clouds in its atmosphere," said Michael Liu of the University of Hawaii's Institute for Astronomy, who is lead author of the paper describing this new work. "In fact, once we start taking images of gas-giant planets around Sun-like stars in the near future, I expect that many of them will look like CFBDSIR 1458+10B."

Unravelling the secrets of this unique object involved exploiting the power of three different telescopes. CFBDSIR 1458+10 was first found to be a binary using the Laser Guide Star (LGS) Adaptive Optics system on the Keck II Telescope in Hawaii [3]. Liu and his colleagues then employed the Canada-France-Hawaii Telescope, also in Hawaii, to determine the distance to the brown dwarf duo using an infrared camera [4]. Finally the ESO VLT was used to study the object's infrared spectrum and measure its temperature.

The hunt for cool objects is a very active astronomical hot topic. The Spitzer Space Telescope has recently identified two other very faint objects as other possible contenders for the coolest known brown dwarfs, although their temperatures have not been measured so precisely. Future observations will better determine how these objects compare to CFBDSIR 1458+10B. Liu and his colleagues are planning to observe CFBDSIR 1458+10B again to better determine its properties and to begin mapping the binary's orbit, which, after about a decade of monitoring, should allow astronomers to determine the binary's mass.

Notes

[1] CFBDSIR 1458+10 is the name of the binary system. The two components are known as CFBDSIR 1458+10A and CFBDSIR 1458+10B, with the latter the fainter and cooler of the two. They seem to be orbiting each other at a separation of about three times the distance between Earth and the Sun in a period of about thirty years.
[2] By comparison the temperature of the surface of the Sun is about 5500 degrees Celsius.
[3] Adaptive optics cancels out much of Earth's atmospheric interference, improving the image sharpness by a factor of ten and enabling the very small separation binary to be resolved.
[4] The astronomers measured the apparent motion of the brown dwarfs against the background of more distant stars caused by Earth's changing position in its orbit around the Sun. The effect, known as parallax, allowed them to determine the distance to the brown dwarfs.

More information

This research was presented in a paper, "CFBDSIR J1458+1013B: A Very Cold (>T10) Brown Dwarf in a Binary System," Liu et al. to appear in the Astrophysical Journal.
The team is composed of Michael C. Liu (Institute for Astronomy [IfA], University of Hawaii, USA), Philippe Delorme (Institut de planétologie et d'astrophysique de Grenoble, CNRS/Université Joseph Fourier, France [IPAG]), Trent J. Dupuy (Harvard-Smithsonian Center for Astrophysics, Cambridge, USA), Brendan P. Bowler (IfA), Loic Albert (Canada-France-Hawaii Telescope Corporation, Hawaii, USA), Etienne Artigau (Université de Montréal, Canada), Celine Reylé (Observatoire de Besançon, France), Thierry Forveille (IPAG) and Xavier Delfosse (IPAG).

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/2011/03/110323103909.htm

Self-Strengthening Nanocomposite Created

Rice University graduate student Brent Carey positions a piece of nanocomposite material in the dynamic mechanical analysis device. He used the device to compress the material 3.5 million times over about a week, proving that the nanocomposite stiffens under strain. The research is the subject of a new paper in the journal ACS Nano. (Credit: Jeff Fitlow/Rice University)

ScienceDaily (Mar. 24, 2011) — Researchers at Rice University have created a synthetic material that gets stronger from repeated stress much like the body strengthens bones and muscles after repeated workouts.

Work by the Rice lab of Pulickel Ajayan, professor in mechanical engineering and materials science and of chemistry, shows the potential of stiffening polymer-based nanocomposites with carbon nanotube fillers. The team reported its discovery this month in the journal *ACS Nano*.

The trick, it seems, lies in the complex, dynamic interface between nanostructures and polymers in carefully engineered nanocomposite materials.

Brent Carey, a graduate student in Ajayan's lab, found the interesting property while testing the high-cycle fatigue properties of a composite he made by infiltrating a forest of vertically aligned, multiwalled nanotubes with polydimethylsiloxane (PDMS), an inert, rubbery polymer. To his great surprise, repeatedly loading the material didn't seem to damage it at all. In fact, the stress made it stiffer.

Carey, whose research is sponsored by a NASA fellowship, used dynamic mechanical analysis (DMA) to test their material. He found that after an astounding 3.5 million compressions (five per second) over about a week's time, the stiffness of the composite had increased by 12 percent and showed the potential for even further improvement.

"It took a bit of tweaking to get the instrument to do this," Carey said. "DMA generally assumes that your material isn't changing in any permanent way. In the early tests, the software kept telling me, 'I've damaged the sample!' as the stiffness increased. I also had to trick it with an unsolvable program loop to achieve the high number of cycles."

Materials scientists know that metals can strain-harden during repeated deformation, a result of the creation and jamming of defects -- known as dislocations -- in their crystalline lattice. Polymers, which are made of long, repeating chains of atoms, don't behave the same way.

The team is not sure precisely why their synthetic material behaves as it does. "We were able to rule out further cross-linking in the polymer as an explanation," Carey said. "The data shows that there's very little chemical interaction, if any, between the polymer and the nanotubes, and it seems that this fluid interface is evolving during stressing."

"The use of nanomaterials as a filler increases this interfacial area tremendously for the same amount of filler material added," Ajayan said. "Hence, the resulting interfacial effects are amplified as compared with conventional composites.

"For engineered materials, people would love to have a composite like this," he said. "This work shows how nanomaterials in composites can be creatively used."

They also found one other truth about this unique phenomenon: Simply compressing the material didn't change its properties; only dynamic stress -- deforming it again and again -- made it stiffer.

Carey drew an analogy between their material and bones. "As long as you're regularly stressing a bone in the body, it will remain strong," he said. "For example, the bones in the racket arm of a tennis player are denser. Essentially, this is an adaptive effect our body uses to withstand the loads applied to it.
"Our material is similar in the sense that a static load on our composite doesn't cause a change. You have to dynamically stress it in order to improve it."
Cartilage may be a better comparison -- and possibly even a future candidate for nanocomposite replacement. "We can envision this response being attractive for developing artificial cartilage that can respond to the forces being applied to it but remains pliable in areas that are not being stressed," Carey said.
Both researchers noted this is the kind of basic research that asks more questions than it answers. While they can easily measure the material's bulk properties, it's an entirely different story to understand how the polymer and nanotubes interact at the nanoscale.
"People have been trying to address the question of how the polymer layer around a nanoparticle behaves," Ajayan said. "It's a very complicated problem. But fundamentally, it's important if you're an engineer of nanocomposites.
"From that perspective, I think this is a beautiful result. It tells us that it's feasible to engineer interfaces that make the material do unconventional things."

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

Journal Reference:

1. Brent J. Carey, Prabir K. Patra, Lijie Ci, Glaura G. Silva, Pulickel M. Ajayan. **Observation of Dynamic Strain Hardening in Polymer Nanocomposites**. *ACS Nano*, 2011; 110321121458018 DOI: 10.1021/nn103104g

http://www.sciencedaily.com/releases/2011/03/110323141854.htm

Scientists Find a Key to Maintaining Our DNA: Provides New Clues in Quest to Slow Aging

Humans have two routes for DNA replication and repair -- a standard route that processes DNA quickly but less accurately, and a high-accuracy route that processes DNA slowly but more accurately. (Credit: Image courtesy of University of Rochester Medical Center)

ScienceDaily (Mar. 24, 2011) — DNA contains all of the genetic instructions that make us who we are, and maintaining the integrity of our DNA over the course of a lifetime is a critical, yet complex part of the aging process. In an important, albeit early step forward, scientists have discovered how DNA maintenance is regulated, opening the door to interventions that may enhance the body's natural preservation of genetic information.

The new findings may help researchers delay the onset of aging and aging-related diseases by curbing the loss or damage of our genetic makeup, which makes us more susceptible to cancers and neurodegenerative diseases, such as Alzheimer's. Keeping our DNA intact longer into our later years could help eliminate the sickness and suffering that often goes hand-in-hand with old age.

"Our research is in the very early stages, but there is great potential here, with the capacity to change the human experience," said Robert Bambara, Ph.D., chair of the Department of Biochemistry and Biophysics at the University of Rochester Medical Center and leader of the research. "Just the very notion is inspiring."

In the *Journal of Biological Chemistry*, Bambara and colleagues report that a process called acetylation regulates the maintenance of our DNA. The team has discovered that acetylation determines the degree of fidelity of both DNA replication and repair.

The finding builds on past research, which established that as humans evolved, we created two routes for DNA replication and repair -- a standard route that eliminates some damage and a moderate amount of errors, and an elite route that eliminates the large majority of damage and errors from our DNA.

Only the small portion of our DNA that directs the creation of all the proteins we are made of -- proteins in blood cells, heart cells, liver cells and so on -- takes the elite route, which uses much more energy and so "costs" the body more. The remaining majority of our DNA, which is not responsible for creating proteins, takes the standard route, which requires fewer resources.

But, scientists have never understood what controls which pathway a given piece of DNA would go down. Study authors found, that like a policeman directing traffic at a busy intersection, acetylation directs which proteins take which route, favoring the protection of DNA that creates proteins by shuttling them down the elite, more accurate course.

"If we found a way to improve the protection of DNA that guides protein production, basically boosting what our body already does to eliminate errors, it could help us live longer," said Lata Balakrishnan, Ph.D., postdoctoral research associate at the Medical Center, who helped lead the work. "A medication that would

cause a small alteration in this acetylation-based regulatory mechanism might change the average onset of cancers or neurological diseases to well beyond the current human lifespan."
"Clearly, a simple preventative approach would be a key, not to immortality, but to longer, disease-free lives," added Bambara.
DNA replication is an intricate, error-prone process, which takes place when our cells divide and our DNA is duplicated. Duplicate copies of DNA are first made in separate pieces, that later must be joined to create a new, full strand of DNA. The first half of each separate DNA segment usually contains the most errors, while mistakes are less likely to appear in the latter half.
For DNA that travels down the standard route, the first 20 percent of each separate DNA segment is tagged, cut off and removed. This empty space is then backfilled with the latter part -- which is the more accurate section -- of the adjoining piece of DNA as the two segments come together to form a full strand.
In contrast, DNA that travels down the elite route gets special treatment: the first 30 to 40 percent of each separate DNA segment is tagged, removed and backfilled, meaning more mistakes and errors are eliminated before the segments are joined. The end result is a more accurate copy of DNA.
The same situation occurs with the DNA repair process, as the body works to remove damaged pieces of DNA.
Unlike the current work, the majority of aging-related research zeroes in on specific agents that damage our DNA, called reactive oxygen species, and how to reduce them. The new research represents a small piece of the pie, but has the potential to be a very important one.
Bambara's team is investigating the newly identified acetylation regulatory process further to figure out how they might be able to intervene to augment the body's natural safeguarding of important genetic information. They are studying human and yeast cell systems to determine how proteins in cells work together to trigger acetylation, which adds a specific chemical to the proteins involved in DNA replication and repair. Researchers are manipulating cells in various ways, through damage or genetic alterations, to see if these changes activate or influence acetylation in any way.
Though they are far from identifying compounds or existing drugs to test, they do see this research having an impact in the future.
"The translational rate is becoming better and better. Today, the course between initial discovery and drug development is intrinsically faster. I could see having some sort of therapeutic that helps us live longer and healthier lives in 25 years," said Bambara.
The work was funded by the National Institute of General Medical Sciences at the National Institutes of Health. In addition to the researchers at Rochester, Ulrich Hübscher, D.V.M., from the University of Zurich and Judith Campbell, Ph.D., from the California Institute of Technology contributed to the research.

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

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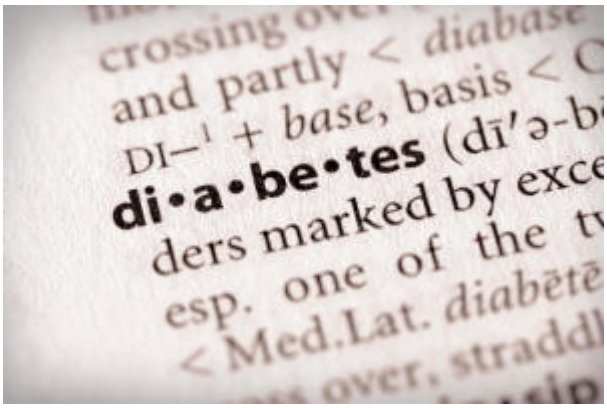
Drug Prevents Type 2 Diabetes in Majority of High-Risk Individuals



An oral pill already in wide use prevented Type 2 diabetes in 72 percent of individuals at high risk for the disease, a multicenter study has found. (Credit: iStockphoto/Mark Poprocki)

ScienceDaily (Mar. 23, 2011) — A pill taken once a day in the morning prevented type 2 diabetes in more than 70 percent of individuals whose obesity, ethnicity and other markers put them at highest risk for the disease, U.S. scientists report.

The team also noted a 31 percent decrease in the rate of thickening of the carotid artery, the major vessel that supplies blood to the brain. The study, which enrolled 602 participants through The University of Texas Health Science Center San Antonio and seven collaborating centers, is described in the *New England Journal of Medicine* and has direct implications for the care of 40 million Americans who are pre-diabetic.

"It's a blockbuster study," said senior author Ralph DeFronzo, M.D., professor in the School of Medicine and chief of the diabetes division at the UT Health Science Center San Antonio. "The 72 percent reduction is the largest decrease in the conversion rate of pre-diabetes to diabetes that has ever been demonstrated by any intervention, be it diet, exercise or medication."

Multiple-year follow-up

Dr. DeFronzo led the trial of pioglitazone, which is marketed as Actos® by Takeda Pharmaceutical Co. Ltd. The Japanese company provided an independent investigator grant to Dr. DeFronzo to conduct the ACT Now study. Some patients were followed for as long as four years; the average follow-up was 2.4 years.

Pioglitazone is widely used as an insulin sensitizer in patients with type 2 diabetes. In the ACT Now study, participants were chosen because of their high risk for diabetes, including obesity, family history and impaired glucose tolerance as demonstrated by a glucose test.

"The drug shows outstanding results," said Robert R. Henry, M.D., president, medicine and science, of the American Diabetes Association. "It is the most efficacious method we have studied to date to delay or prevent the onset of type 2 diabetes." A study co-investigator, Dr. Henry is professor of medicine at the University of California, San Diego, and chief of the section of endocrinology and diabetes at the VA San Diego Healthcare System.

Blood vessel damage prevented

Robert Chilton, D.O., FACC, a UT Health Science Center San Antonio cardiologist who was not involved with the study, said the slowing of carotid artery thickness indicated that the participants' glucose was well controlled, preventing blood vessel damage that leads to heart attacks, strokes and peripheral vascular disease. Individuals who have diabetes have the same high risk of having a first heart attack as do non-diabetic people who already had a heart attack, he noted.

"The drug was able to postpone conversion to diabetes in 72 percent of people," Dr. Chilton said. "The only thing that could potentially beat that is the free pill no one seems to be able to take -- diet and exercise."

Insulin resistance

Type 2 diabetes involves abnormalities with insulin, a hormone secreted by beta cells in the pancreas. Insulin helps the body store and use sugar from food, but in type 2 diabetes the body is insulin resistant, that is, it inefficiently responds to the hormone. With time the beta cells in diabetic patients start to die, resulting in less

insulin to handle the demands. Levels of the hormone become progressively lower and sugar levels are increased progressively, damaging blood vessels and organs.
Dr. Henry said the ACT Now study highlights the importance of insulin resistance in the development of type 2 diabetes and how, by treating this resistance, the beta cell secretion of insulin is preserved for a longer period of time.
Pioglitazone was well tolerated by participants, with weight gain and fluid retention observed at the dose used in the study. Dr. DeFronzo said those side effects can be mitigated by using a lower dose that works equally well. Pioglitazone stimulates appetite while at the same time shifting fat around in the body, taking it out of muscle, the liver and beta cells and putting it in subcutaneous fat depots under the skin where it is inert and not harmful, he said.
"No drug is perfect," Dr. DeFronzo said. "This particular medication does two things -- improves insulin resistance and improves beta cell function, which are the two core defects of diabetes."

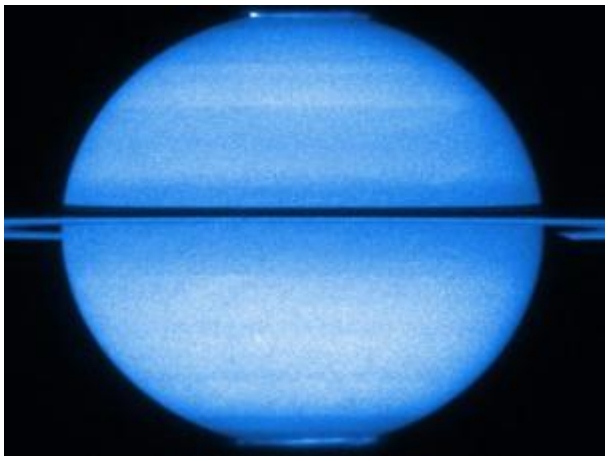
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of Texas Health Science Center at San Antonio**, via EurekAlert!, a service of AAAS.

Journal Reference:

1. Ralph A. DeFronzo, Devjit Tripathy, Dawn C. Schwenke, MaryAnn Banerji, George A. Bray, Thomas A. Buchanan, Stephen C. Clement, Robert R. Henry, Howard N. Hodis, Abbas E. Kitabchi, Wendy J. Mack, Sunder Mudaliar, Robert E. Ratner, Ken Williams, Frankie B. Stentz, Nicolas Musi, Peter D. Reaven. **Pioglitazone for Diabetes Prevention in Impaired Glucose Tolerance**. *New England Journal of Medicine*, 2011; 364 (12): 1104 DOI: 10.1056/NEJMoa1010949

http://www.sciencedaily.com/releases/2011/03/110323183808.htm

Cassini Finds Saturn Sends Mixed Signals



This unique image from NASA/ESA's Hubble Space Telescope from early 2009 features Saturn with the rings edge-on and both poles in view, offering a stunning double view of its fluttering auroras. (Credit: NASA/ESA/STScI/University of Leicester)

ScienceDaily (Mar. 23, 2011) — Like a petulant adolescent, Saturn is sending out mixed signals.

Recent data from NASA's Cassini spacecraft show that the variation in radio waves controlled by the planet's rotation is different in the northern and southern hemispheres. Moreover, the northern and southern rotational variations also appear to change with the Saturnian seasons, and the hemispheres have actually swapped rates. These two radio waves, converted to the human audio range, can be heard in a new video available online at: http://www.nasa.gov/multimedia/videogallery/index.html?media_id=74390781

"These data just go to show how weird Saturn is," said Don Gurnett, Cassini's radio and plasma wave science instrument team lead and professor of physics at the University of Iowa, Iowa City. "We thought we understood these radio wave patterns at gas giants, since Jupiter was so straightforward. Without Cassini's long stay, scientists wouldn't have understood that the radio emissions from Saturn are so different."

Saturn emits radio waves known as Saturn Kilometric Radiation, or SKR for short. To Cassini, they sound a bit like bursts of a spinning air raid siren, since the radio waves vary with each rotation of the planet. This kind of radio wave pattern had been previously used at Jupiter to measure the planet's rotation rate, but at Saturn, as is the case with teenagers, the situation turned out to be much more complicated.

When NASA's Voyager spacecraft visited Saturn in the early 1980s, the radiation emissions indicated the length of Saturn's day was about 10.66 hours. But as its clocking continued by a flyby of the joint ESA-NASA Ulysses spacecraft and Cassini, the radio burst varied by seconds to minutes. A paper in Geophysical Research Letters in 2009 analyzing Cassini data showed that the Saturn Kilometric Radiation was not even a solo, but a duet, with two singers out of sync. Radio waves emanating from near the north pole had a period of around 10.6 hours; radio waves near the south pole had a period of around 10.8 hours.

A new paper led by Gurnett that was published in Geophysical Research Letters in December 2010 shows that, in recent Cassini data, the southern and northern SKR periods crossed over around March 2010, about seven months after equinox, when the sun shines directly over a planet's equator. The southern SKR period decreased from about 10.8 hours on Jan. 1, 2008 and crossed with the northern SKR period around March 1, 2010, at around 10.67 hours. The northern period increased from about 10.58 hours to that convergence point.

Seeing this kind of crossover led the Cassini scientists to go back into data from previous Saturnian visits. With a new eye, they saw that NASA's Voyager data taken in 1980, about a year after Saturn's 1979 equinox, showed different warbles from Saturn's northern and southern poles. They also saw a similar kind of effect in the Ulysses radio data between 1993 and 2000. The northern and southern periods detected by Ulysses converged and crossed over around August 1996, about nine months after the previous Saturnian equinox.

Cassini scientists don't think the differences in the radio wave periods had to do with hemispheres actually rotating at different rates, but more likely came from variations in high-altitude winds in the northern and southern hemispheres. Two other papers involving Cassini investigators were published in December, with results complementary to the radio and plasma wave science instrument -- one by Jon Nichols, University of

Leicester, U.K., in the same issue of Geophysical Research Letters, and the other led by David Andrews, also of University of Leicester, in the Journal of Geophysical Research.
In the Nichols paper, data from the NASA/ESA Hubble Space Telescope showed the northern and southern auroras on Saturn wobbled back and forth in latitude in a pattern matching the radio wave variations, from January to March 2009, just before equinox. The radio signal and aurora data are complementary because they are both related to the behavior of the magnetic bubble around Saturn, known as the magnetosphere. The paper by Andrews, a Cassini magnetometer team associate, showed that from mid-2004 to mid-2009, Saturn's magnetic field over the two poles wobbled at the same separate periods as the radio waves and the aurora.
"The rain of electrons into the atmosphere that produces the auroras also produces the radio emissions and affects the magnetic field, so scientists think that all these variations we see are related to the sun's changing influence on the planet," said Stanley Cowley, a co-author on both papers, co-investigator on Cassini's magnetometer instrument, and professor at the University of Leicester.
As the sun continues to climb towards the north pole of Saturn, Gurnett's group has continued to see the crossover trend in radio signals through Jan. 1, 2011. The period of the southern radio signals continued to decrease to about 10.54 hours, while the period of the northern radio signals increased to 10.71 hours.
"These papers are important in helping to explain the complicated dance between the sun and Saturn's magnetic bubble, something normally invisible to the human eye and imperceptible to the human ear," said Marcia Burton, a Cassini fields and particles scientist at NASA's Jet Propulsion Laboratory, Pasadena, Calif., who was not involved in the work. "Cassini will continue to keep an eye on these changes."
The Cassini-Huygens mission is a cooperative project of NASA, the European Space Agency and the Italian Space Agency. JPL, a division of the California Institute of Technology in Pasadena, manages the mission for NASA's Science Mission Directorate, Washington, D.C. The Cassini orbiter and its two onboard cameras were designed, developed and assembled at JPL. The radio and plasma wave science team is based at the University of Iowa, Iowa City, where the instrument was built. The magnetometer team is based at Imperial College, London, U.K.
The Hubble Space Telescope is a project of international cooperation between NASA and the European Space Agency. NASA's Goddard Space Flight Center manages the telescope. The Space Telescope Science Institute conducts Hubble science operations. STScI is operated for NASA by the Association of Universities for Research in Astronomy, Inc., in Washington, D.C.

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/2011/03/110323145552.htm

Tree Resin Captures Key Evidence of Current and Ancient Insect Invasions

Scientists have discovered that insects that bore into trees as long ago as 90 million years, or as recently as last summer, leave a calling card that's rich with information. (Credit: Image courtesy of University of Alberta)

ScienceDaily (Mar. 23, 2011) — A University of Alberta-led research team has discovered that insects that bore into trees as long ago as 90 million years, or as recently as last summer, leave a calling card that's rich with information.

The information is contained in the resin found within trees and on their bark. Resin is produced in large quantities by a tree when it's under attack by insects.

Normally, to assess if a tree is under an attack from boring insects researchers have sometimes had to rip patches of bark from healthy trees. But now forestry workers looking for the telltale sign of insect borings in tree trunks have a far less invasive method -- they can just examine the resin that collects in clumps on the tree trunk.

An attack by boring beetles typically affects trees in two ways. The boring action damages the phloem layer just under the bark, which cuts off the passage of nutrients within the trunk. Also, beetles often introduce a fungus that spreads into the woody xylem tissue of the tree and starves the treetop of water. A side-effect of insect invasion and water stress is a reduction in the tree's ability to absorb carbon dioxide from the atmosphere. Carbon dioxide is necessary for life-sustaining photosynthesis.

The research team, including U of A paleontology graduate student Ryan McKellar, looked for subatomic-sized isotopic evidence that indicates water stress levels in trees as a result of an insect attack.

The team discovered a common marker in carbon isotopes found in the resin of living trees under insect attack and in the fossilized resin or amber produced by ancient trees going as far back as the age of dinosaurs: they both contain elevated levels of carbon-13.

McKellar's group also found evidence of boring beetles and the increased presence of carbon-13 within amber fossils dating back in the geological record to 90 million and 17 million years ago. The locations are as geographically removed as present-day New Jersey and the Dominican Republic.

With this finding the researchers suggest that two or the world's major amber deposits may have been produced by insect attacks like mountain pine beetle that are seen in modern ecosystems.

This discovery will help researchers understand the history of insect infestations.

McKellar's research will be published March 23 in *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 Alberta**, via EurekAlert!, a service of AAAS.

Journal Reference:

1. R. C. McKellar, A. P. Wolfe, K. Muehlenbachs, R. Tappert, M. S. Engel, T. Cheng, G. A. Sanchez-Azofeifa. **Insect outbreaks produce distinctive carbon isotope signatures in defensive resins and fossiliferous ambers**. *Proceedings of the Royal Society B: Biological Sciences*, 2011; DOI: 10.1098/rspb.2011.0276

http://www.sciencedaily.com/releases/2011/03/110322224325.htm

First Image of Protein Residue in 50-Million-Year-Old Reptile Skin

Above: 50-million-year-old reptile skin from the Green River Formation, Utah. A team of researchers led by the University of Manchester in the UK have used modern infrared technology to show that protein residue has survived within the remarkably preserved skin. The small sample is about 8 cm long. (Credit: N. P. Edwards)

ScienceDaily (Mar. 23, 2011) — The organic compounds surviving in 50-million-year-old fossilized reptile skin can be seen for the first time, thanks to a stunning infrared image produced by University of Manchester palaeontologists and geochemists.

Published in the journal *Royal Society Proceedings B: Biology*, the brightly-coloured image shows the presence of amides -- organic compounds that serve as building blocks of life -- in the ancient skin of a reptile, found in the 50-million-year-old rocks of the Green River Formation in Utah.

This image had never been seen by the human eye, until a team led by Dr Roy Wogelius and Dr Phil Manning used state-of-the-art infrared technology at The University of Manchester to reveal and map the fossilized soft tissue of a beautifully-preserved reptile.

These infrared maps are backed up by the first ever element-specific maps of organic material in fossil skin generated using X-rays at the Stanford synchrotron in the USA, also by the Manchester researchers.

Chemical details are clear enough that the scientists, from the School of Earth, Atmospheric and Environmental Sciences, are even able to propose how this exceptional preservation occurs.

When the original compounds in the skin begin to break down they can form chemical bonds with trace metals, and under exceptional conditions these trace metals act like a 'bridge' to minerals in the sediments. This protects the skin material from being washed away or decomposing further.

Geochemist Roy Wogelius said: "The mapped distributions of organic compounds and trace metals in 50 million year old skin look so much like maps we've made of modern lizard skin as a check on our work, it is sometimes hard to tell which is the fossil and which is fresh."

"These new infrared and X-ray methods reveal intricate chemical patterns that have been overlooked by traditional methods for decades."

The new images are compelling, and represent the next step in the academics' research programme to use modern analytical chemistry and 21st century techniques to understand how such remarkable preservation occurs, and ultimately to discover the chemistry of ancient life.

These new results imply that trace metal inventories and patterns in ancient reptile skin, even after fossilisation, can indeed be compared to modern reptiles.

The infrared light causes vibrations in the fossilized skin, and a map of where these vibrations occur can be obtained from a fossil by using a trick: a tiny crystal (like an old phonograph record stylus) which moves from point-to-point in a programmable grid across the surface.

At each point where the tiny crystal touches the fossil, an infrared beam that shines through the crystal reflects off of the crystal base, but a small amount of the beam probes beyond the interface- and if organic compounds are present, they absorb portions of the beam and change the reflected signal.

This allows the team to non-destructively map large fossils which do not themselves transmit or reflect the beam -- a revolutionary process for paleontologists.

Nick Edwards, first author on the publication, said: "The ability to chemically analyse rare and precious fossils such as these without the need to remove material and destroy them is an important and long overdue addition to field of palaeontology.
"Hopefully this will provide future opportunities to unlock the information stored in other similarly preserved specimens."
Dr Manning said: "Here physics, palaeontology and chemistry have collided to yield incredible insight to the building blocks of fossilized soft tissue.
"The results of this study have wider implications, such as understanding what happens to buried wastes over long periods of time. The fossil record provides us with a long-running experiment, from which we can learn in order to help resolve current problems."

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

Journal Reference:

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http://www.sciencedaily.com/releases/2011/03/110322224314.htm

Chemist Develops Technique to Use Light to Predict Molecular Crystal Structures

Timothy Korter has developed a way to use very low frequency light waves to study the weak forces (London dispersion forces) that hold molecules together in a crystal. This fundamental research could be applied to solve critical problems in drug research, manufacturing and quality control. (Credit: Image courtesy of Syracuse University)

ScienceDaily (Mar. 24, 2011) — A Syracuse University chemist has developed a way to use very low frequency light waves to study the weak forces (London dispersion forces) that hold molecules together in a crystal. This fundamental research could be applied to solve critical problems in drug research, manufacturing and quality control.

The research by Timothy Korter, associate professor of chemistry in SU's College of Arts and Sciences, was the cover article of the March 14 issue of *Physical Chemistry Chemical Physics*.

"When developing a drug, it is important that we uncover all of the possible ways the molecules can pack together to form a crystal," Korter says. "Changes in the crystal structure can change the way the drug is absorbed and accessed by the body."

One industry example is that of a drug distributed in the form of a gel capsule that crystallized into a solid when left on the shelf for an extended period of time, Korter explains. The medication inside the capsule changed to a form that could not dissolve in the human body, rendering it useless. The drug was removed from shelves. This example shows that it is not always possible for drug companies to identify all the variations of a drug's crystal structure through traditional experimentation, which is time consuming and expensive.

"The question is," Korter says, "can we leverage a better understanding of London and other weak intermolecular forces to predict these changes in crystal structure?"

Korter's lab is one of only a handful of university-based research labs in the world exploring the potential of THz radiation for chemical and pharmaceutical applications. THz light waves exist in the region between infrared radiation and microwaves and offer the unique advantages of being non-harmful to people and able to safely pass through many kinds of materials. THz can also be used to identify the chemical signatures of a wide range of substances. Korter has used THz to identify the chemical of signatures of molecules ranging from improvised explosives and drug components to the building blocks of DNA.
Korter's new research combines THz experiments with new computational models that accurately account for the effects of the London dispersion forces to predict crystal structures of various substances. London forces are one of several types of intermolecular forces that cause molecules to stick together and form solids. Environmental changes (temperature, humidity, light) impact the forces in ways that can cause the crystal structure to change. Korter's research team compares the computer models with the THz experiments and uses the results to refine and improve the theoretical models.
"We have demonstrated how to use THz to directly visualize these chemical interactions," Korter says. "The ultimate goal is to use these THz signatures to develop theoretical models that take into account the role of these weak forces to predict the crystal structures of pharmaceuticals before they are identified through experimentation."
A National Science Foundation Early Career Development (CAREER) Award funds Korter's research.

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

Journal Reference:

1. Matthew D. King, William D. Buchanan, Timothy M. Korter. **Application of London-type dispersion corrections to the solid-state density functional theory simulation of the terahertz spectra of crystalline pharmaceuticals**. *Physical Chemistry Chemical Physics*, 2011; 13 (10): 4250 DOI: 10.1039/C0CP01595D

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