Infoteca's E-Journal

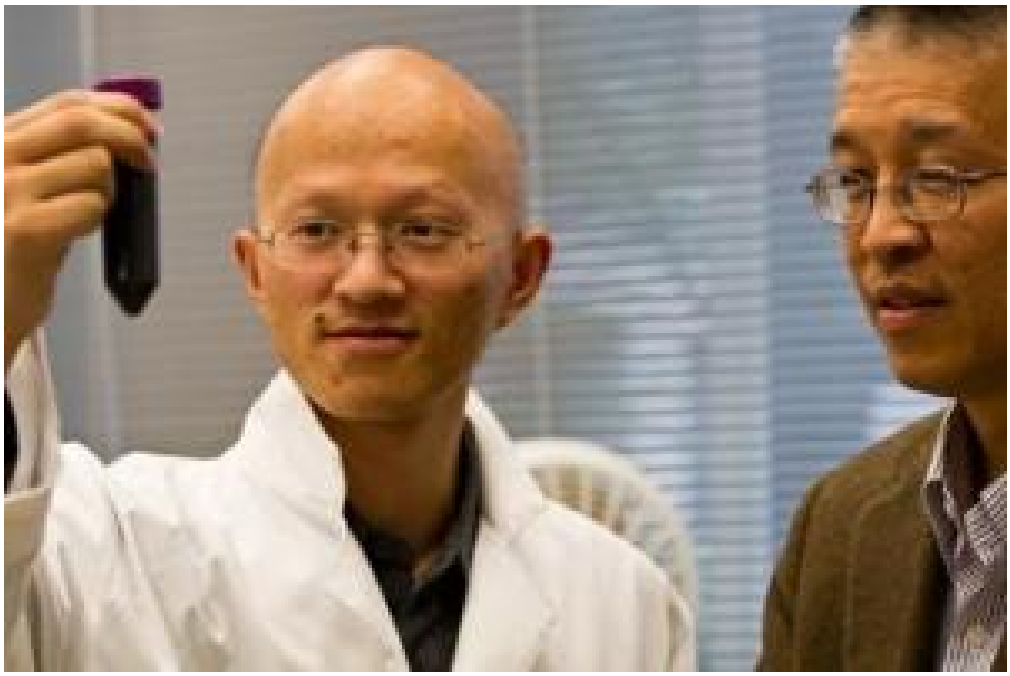
An Electronic Compilation of Scientific and Cultural Information by
Sistema de Infotecas Centrales, Universidad Autónoma de Coahuila

CONTENTS

Reversible Control of Electrical and Thermal Properties Could Find Uses in Storage	3
Reptile 'Cousins' Shed New Light on End-Permian Extinction	5
Tissue-Engineering Platform Enables Heart Tissue to Repair Itself	7
Technology Promises More Effective Prescription Drug Therapies	9
Comet Elenin: Preview of a Coming Attraction	12
Why Sloths and Manatees Have Unusually Long (or Short) Necks	14
Quantum Simulation With Light: Frustrations Between Photon Pairs	16
Physicist Leads Effort to Design Fractal Devices to Put in Eyes	18
Tree Rings Tell a 1,100-Year History of El Niño	20
'Swiss Cheese' Design Enables Thin Film Silicon Solar Cells	22
Robot Engages Novice Computer Scientists	24
Hunting for Deadly Bacteria	26
What Secrets Do Ancient Medical Texts Hold?	28
The Essentials: Six Books on the Civil War	30
Five roboethical principles – for humans	31
Encouragement Boosts Minority Student Success	34
Lee Baca Wants to Educate L.A.'s Prisoners	36
Why Whites Avoid Movies With Black Actors	39
Gas drilling contaminates drinking water	41
Blue alert: The dark side of night light	42
Drug pacemaker relieves hassle of daily shots	46
First evidence that gorillas pass on traditions	47
NASA floats Titan boat concept	48
How to build the global mathematics brain	50
The limits of knowledge: Things we'll never understand	53
Beleaguered mission measures swirling space-time at last	57
Digital legacy: Respecting the digital dead	59
Immature Skull Led Young Tyrannosaurs to Rely on Speed, Agility to Catch Prey	61
New Insect Repellant May Be Thousands of Times Stronger Than DEET	63
'Fool's Gold' Is Ocean Life's Fertilizer	65
Genome of Marine Organism Reveals Hidden Secrets	67
Astronomers Find Newly Discovered Asteroid Is Earth's Companion	69
Caught in the Act: Herschel Detects Gigantic Storms Sweeping Entire Galaxies Clean	71
In a Genetic Research First, Researchers Turn Zebrafish Genes Off and on	73
Zombie Ants Have Fungus on the Brain, New Research Reveals	75
Brain Region That Influences Gambling Decisions Pinpointed	77
A Tiltable Head Could Improve the Ability of Robots to Navigate Disaster Debris	79

Fundamental Question on How Life Started Solved 81
Airborne Pollutants: New View of How Water and Sulfur Dioxide Mix 83
Pleasure Reading Leads to Professional Careers, Study Says 85
Model of the Moment 87
Translating 'Grad Student' Into English 94
Fixing Accreditation, From the Inside 96
Mixed on Media 98
Revision and Patience 99
Beyond Tweets and Blogs 101
NASA's Galileo Reveals Magma 'Ocean' Beneath Surface of Jupiter's Moon 104
Whales Have Accents and Regional Dialects 106
Can Clouds Help Mitigate Global Warming? 108
Why Some Genes Are Silenced 110
On Prehistoric Supercontinent of Pangaea, Latitude and Rain Dictated Where Species Lived 112
Strong, Tough and Now Cheap: New Way to Process Metallic Glass Developed 114
Activated Graphene Makes Superior Supercapacitors for Energy Storage 116
Why People Choose to Cooperate Rather Than Act Selfishly 118
Solar Cells Beat Plants at Harvesting Sun's Energy, for Now 120
A Larger-Than-Life Toussaint Louverture 122
Booting Up a Computer Pioneer's 200-Year-Old Design 124
In Search of the Mysterious Narwhal 126
Fixated by Screens, but Seemingly Nothing Else 133
The Art of Economic Complexity 135
Improving the Science of Teaching Science 137
Early H.I.V. Therapy Sharply Curbs Transmission 139
Tiny Variation in One Gene May Have Led to Crucial Changes in Human Brain 141
Alzheimer's Risk Gene Disrupts Brain's Wiring 50 Years Before Disease Hits 143
'Master Switch' Gene for Obesity and Diabetes Discovered 146
Evolutionary Adaptations Can Be Reversed, but Rarely 148
Physicists Discover Physical Phenomenon That Could Boost Computers' Clock Speed 151
Moon's Rough 'Wrinkles' Reveal Clues to Its Past 153
Research Breakthrough on Male Infertility 155
Single Giant Interneuron in Locusts Controls Activity in 50,000 Neurons 157
The Kitchen-Table Industrialists 159
New Calculations on Blackbody Energy Set the Stage for Clocks 164
Artificial Grammar Reveals Inborn Language Sense, Study Shows 166
Researchers Identify DNA Region Linked to Depression 168
Next Generation Gamers: Computer Games Aid Recovery from Stroke 170
The Atom and Its Quantum Mirror Image 171
Practice, Not Loss of Sight, Improves Sense of Touch in the Blind 173
New Properties of Supercooled Confined Water Discovered 175
Study Reveals Origins of a Cancer Affecting the Blood and Bone Marrow 177
Foot and Mouth Disease May Spread Through Shedding Skin Cells 179
Getting Along With Co-Workers May Prolong Life 181
New Class of Compounds With Great Potential for Research and Drug Development 183
Marine Ecosystems of Antarctica Under Threat from Human Activity 185
Lasers Take the Lead in Auto Manufacturing 188
First Habitable Exoplanet? 191
Will Global Climate Change Enhance Boreal Forest Growth? 193
Applying Neuroscience to Robot Vision 195
Looking Inside Nanomaterials in 3-D 196
Species Are to Ecosystems as Cells Are to the Human Body 198
Beyond Smart Phones: Sensor Network to Make 'Smart Cities' Envisioned 200

New Way to Control Conductivity: Reversible Control of Electrical and Thermal Properties Could Find Uses in Storage Systems



Graduate student Jianjian Wang holds a flask containing the suspension of graphite flakes in hexadecane, as Gang Chen looks on. (Credit: Photo by Melanie Gonick)

ScienceDaily (May 5, 2011) — A team of researchers at MIT has found a way to manipulate both the thermal conductivity and the electrical conductivity of materials simply by changing the external conditions, such as the surrounding temperature. And the technique they found can change electrical conductivity by factors of well over 100, and heat conductivity by more than threefold.

"It's a new way of changing and controlling the properties" of materials -- in this case a class called percolated composite materials -- by controlling their temperature, says Gang Chen, MIT's Carl Richard Soderberg Professor of Power Engineering and director of the Pappalardo Micro and Nano Engineering Laboratories.

Chen is the senior author of a paper describing the process that was published online on April 19 and will appear in a forthcoming issue of *Nature Communications*. The paper's lead authors are former MIT visiting scholars Ruiting Zheng of Beijing Normal University and Jinwei Gao of South China Normal University, along with current MIT graduate student Jianjian Wang. The research was partly supported by grants from the National Science Foundation.

The system Chen and his colleagues developed could be applied to many different materials for either thermal or electrical applications. The finding is so novel, Chen says, that the researchers hope some of their peers will respond with an immediate, "I have a use for that!"

One potential use of the new system, Chen explains, is for a fuse to protect electronic circuitry. In that application, the material would conduct electricity with little resistance under normal, room-temperature conditions. But if the circuit begins to heat up, that heat would increase the material's resistance, until at some threshold temperature it essentially blocks the flow, acting like a blown fuse. But then, instead of needing to be reset, as the circuit cools down the resistance decreases and the circuit automatically resumes its function.

Another possible application is for storing heat, such as from a solar thermal collector system, later using it to heat water or homes or to generate electricity. The system's much-improved thermal conductivity in the solid state helps it transfer heat.

Essentially, what the researchers did was suspend tiny flakes of one material in a liquid that, like water, forms crystals as it solidifies. For their initial experiments, they used flakes of graphite suspended in liquid

hexadecane, but they showed the generality of their process by demonstrating the control of conductivity in other combinations of materials as well. The liquid used in this research has a melting point close to room temperature -- advantageous for operations near ambient conditions -- but the principle should be applicable for high-temperature use as well.

The process works because when the liquid freezes, the pressure of its forming crystal structure pushes the floating particles into closer contact, increasing their electrical and thermal conductance. When it melts, that pressure is relieved and the conductivity goes down. In their experiments, the researchers used a suspension that contained just 0.2 percent graphite flakes by volume. Such suspensions are remarkably stable: Particles remain suspended indefinitely in the liquid, as was shown by examining a container of the mixture three months after mixing.

By selecting different fluids and different materials suspended within that liquid, the critical temperature at which the change takes place can be adjusted at will, Chen says.

"Using phase change to control the conductivity of nanocomposites is a very clever idea," says Li Shi, a professor of mechanical engineering at the University of Texas at Austin. Shi adds that as far as he knows "this is the first report of this novel approach" to producing such a reversible system.

"I think this is a very crucial result," says Joseph Heremans, professor of physics and of mechanical and aerospace engineering at Ohio State University. "Heat switches exist," but involve separate parts made of different materials, whereas "here we have a system with no macroscopic moving parts," he says. "This is excellent work."

Story Source:

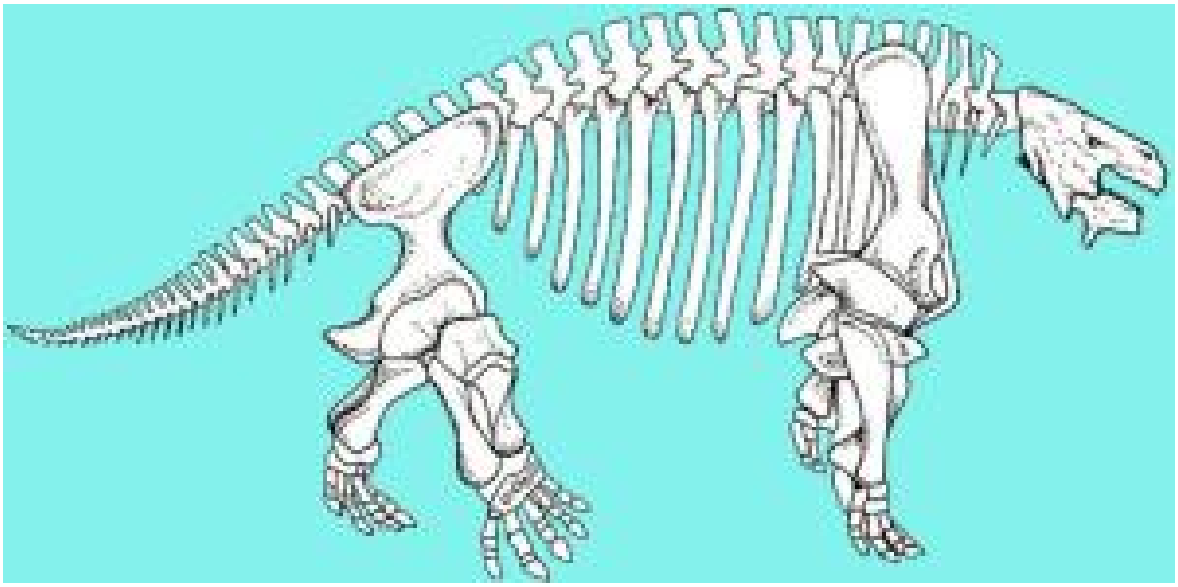
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Massachusetts Institute of Technology**. The original article was written by David L. Chandler, MIT News Office.

Journal Reference:

1. Ruiting Zheng, Jinwei Gao, Jianjian Wang, Gang Chen. **Reversible temperature regulation of electrical and thermal conductivity using liquid–solid phase transitions**. *Nature Communications*, 2011; 2: 289 DOI: 10.1038/ncomms1288

http://www.sciencedaily.com/releases/2011/05/110504103946.htm

Reptile 'Cousins' Shed New Light on End-Permian Extinction



The pareiasaur parareptile Scutosaurus. (Credit: Image by Professor Mike Benton)

ScienceDaily (May 5, 2011) — The end-Permian extinction, by far the most dramatic biological crisis to affect life on Earth, may not have been as catastrophic for some creatures as previously thought, according to a new study led by the University of Bristol.

An international team of researchers studied the parareptiles, a diverse group of bizarre-looking terrestrial vertebrates which varied in shape and size. Some were small, slender, agile and lizard-like creatures, while others attained the size of rhinos; many had knobbly ornaments, fringes, and bony spikes on their skulls.

The researchers found that, surprisingly, parareptiles were not hit much harder by the end-Permian extinction than at any other point in their 90 million-year history. Furthermore, the group as a whole declined and diversified time and time again throughout its history, and it was not until about 50 million years after the end-Permian crisis that the parareptiles finally disappeared.

During the end-Permian extinction, some 250 million years ago, entire groups of animals and plants either vanished altogether or decreased significantly in numbers, and the recovery of the survivors was at times slow and prolonged before new radiations took place.

By studying the fossil record, palaeontologists can examine how individual groups of organisms responded to the end-Permian event and assess just how dramatic it was. However, as the quality and completeness of the fossil record varies considerably, both geographically and stratigraphically, palaeontologists need to find a way to 'join the dots' and piece together the fragments of a complex mosaic to give a more satisfactory and better picture of ancient life's diversity.

The team led by Dr Marcello Ruta of Bristol's School of Earth Sciences, and including scientists from Germany, Brazil and North America, used the evolutionary relationships among known parareptiles to produce a corrected estimate of changing diversity through time.

Dr Marcello Ruta said: "Evolutionary relationships can be superimposed on a time scale, allowing you to infer missing portions of past diversity. They are powerful tools that complement and refine the known record of extinct diversity. If you visualize evolutionary relationships in the form of branching diagrams and then plot them on a time scale, new patterns begin to emerge, with gaps in the fossil record suddenly filling rapidly."

One of the team members, Juan Cisneros of the Universidade Federal do Piauí, Ininga, Brazil said: "It is as if ghosts from the past appear all of a sudden and join their relatives in a big family tree -- you have a bigger tree. This way, you can start analysing observed and extrapolated abundance of species through time, and you can quantify novel origination and extinction events that would otherwise go unnoticed if you were to look at known finds only."

Co-author Johannes Müller of the Museum für Naturkunde, Berlin added: "Researchers who investigate changing diversity through time have a huge battery of basic and advanced analytical and statistical methods at their disposal to study patterns of diversification and extinction. Classic text-book views of waxing and waning of groups through deep time will certainly benefit, where possible, from the use of evolutionary thinking."
University of Washington's Linda Tsuji, also part of the research team, concluded: "This is the first time that the history of parareptiles has been examined in such detail. But this is only the beginning. These bizarre-looking vertebrates continue to inspire generations of researchers, not only those interested in mass extinctions. They are abundant, diverse, and we still know very little about their biology. We hope that this study will initiate a more in-depth study of the response of terrestrial vertebrates to global catastrophes."
The new findings are published online in the journal *Palaeontology*.

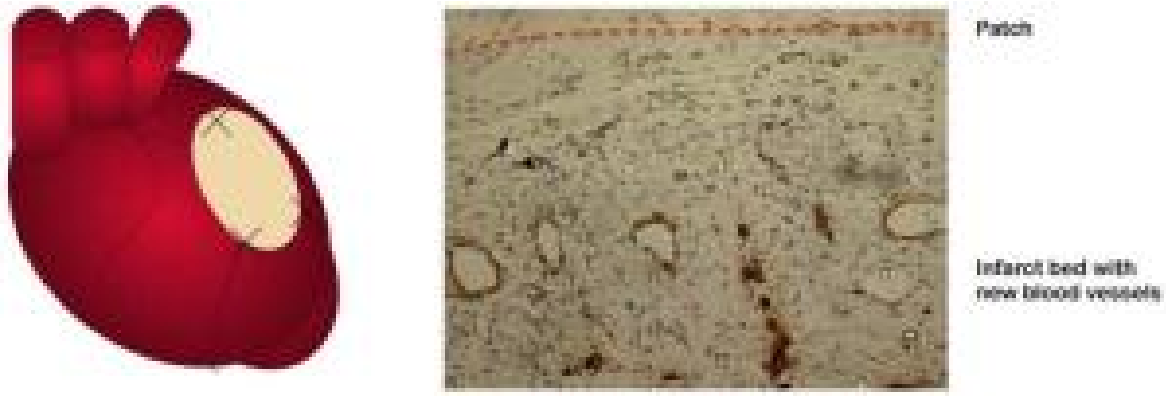
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of Bristol**.

Journal Reference:

1. Marcello Ruta, Juan C. Cisneros, Torsten Liebrecht, Linda A. Tsuji, Johannes Müller. **Amniotes through major biological crises: faunal turnover among parareptiles and the end-Permian mass extinction**. *Palaeontology*, 2011; DOI: 10.1111/j.1475-4983.2011.01051.x

http://www.sciencedaily.com/releases/2011/05/110505103339.htm

Engineers Patch a Heart: Tissue-Engineering Platform Enables Heart Tissue to Repair Itself



Engineering researchers have established a new method to patch a damaged heart using a tissue-engineering platform that enables heart tissue to repair itself. (Credit: Image courtesy of Columbia University)

ScienceDaily (May 6, 2011) — Researchers at Columbia Engineering have established a new method to patch a damaged heart using a tissue-engineering platform that enables heart tissue to repair itself. This breakthrough, recently published in the *Proceedings of the National Academy of Sciences*, is an important step forward in combating cardiovascular disease, one of the most serious health problems of our day.

Led by Gordana Vunjak-Novakovic, Professor of Biomedical Engineering at Columbia University's Fu Foundation School of Engineering and Applied Science, the researchers developed a novel cell therapy to treat myocardial infarction (heart damage that follows a heart attack). They were able, for the first time, to combine the use of human repair cells that were conditioned during in-vitro culture to maximize their ability to revascularize and improve blood flow to the infarcted tissue with a fully biological composite scaffold designed to deliver these cells to the damaged heart. With this platform, they could both keep the cells within the infarct bed (in contrast to the massive cell loss associated with infusion of cells alone) and enhance cell survival and function in the infarct bed, where most of the cells would have died because of the obstruction of their blood supply.

"We are very excited about this new technique," said Dr. Vunjak-Novakovic. "This platform is very adaptable and we believe it could be readily extended to the delivery of other types of human stem cells we are interested in to rebuild the heart muscle and further our research of the mechanisms underlying heart repair."

In effect, the Columbia Engineering team (with Amandine Godier-Fournemont and Timothy Martens as lead authors) removed the cells of a human heart muscle -- the myocardium -- leaving a protein scaffold with intact architecture and mechanical properties. They filled the scaffold with human mesenchymal progenitors (stem cells that can differentiate into many cell types) and then applied the patches to damaged heart tissue. The patches promoted the growth of new blood vessels and released proteins that stimulated the native tissue to repair itself. Moreover, the team also used this controllable platform to identify the signaling mechanisms involved in the repair process, and expand our knowledge about the role of cells and scaffold design on heart repair.

"It really is encouraging to make progress with 'instructing' cells to form human tissues by providing them with the right environments," noted Dr. Vunjak-Novakovic. "The cells are the real 'tissue engineers' -- we only design the environments so they can do their work. Because these environments need to mimic the native developmental milieu, the progress in the field is really driven by the interdisciplinary work of bioengineers, stem cell biologists, and clinicians. By enabling regeneration and replacement of our damaged tissues, we can help people live longer and better."

Dr. Vunjak-Novakovic and her team already have several active research projects that continue this line of work. They are now investigating the formation of a contractile cardiac patch using human stem cells that can give rise to both the muscle and vascular compartments of the heart muscle. They are also studying how the cells within such a cardiac patch, when implanted on infarcted heart tissue, develop their ability to generate mechanical force and electrical conduction, and how these functions can be modulated by in-vitro culture.

"Ultimately, we envision this system as a possible point of care approach," said Dr. Vunjak-Novakovic, "with components actually produced and assembled in the operating room to most effectively target-signaling mechanisms involved in the repair process of someone's damaged heart."
The Columbia Engineering study has been supported by the NIH (National Institutes of Health).

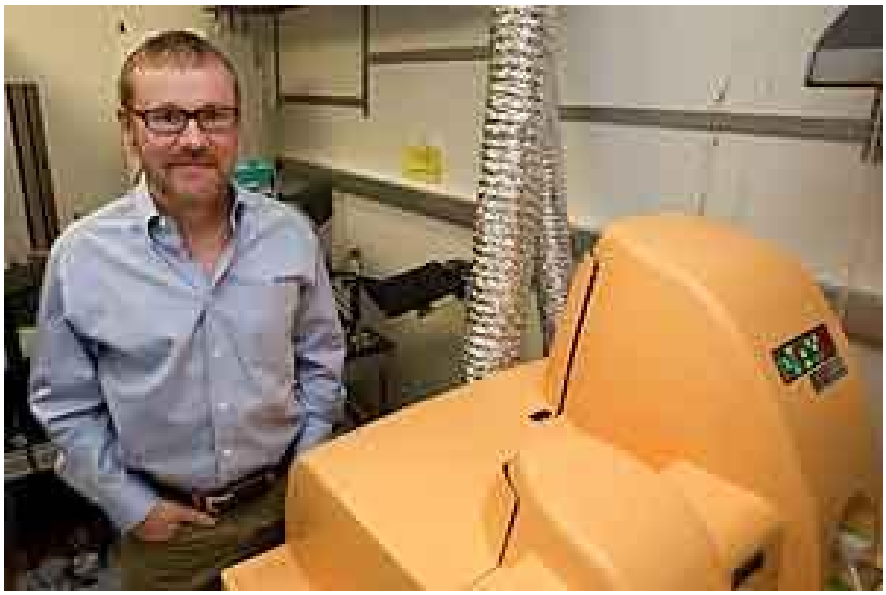
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Columbia University**.

Journal Reference:

1. A. F. G. Godier-Furnemont, T. P. Martens, M. S. Koeckert, L. Wan, J. Parks, K. Arai, G. Zhang, B. Hudson, S. Homma, G. Vunjak-Novakovic. **Composite scaffold provides a cell delivery platform for cardiovascular repair**. *Proceedings of the National Academy of Sciences*, 2011; DOI: 10.1073/pnas.1104619108

http://www.sciencedaily.com/releases/2011/05/110506171905.htm

Advanced Instrument Analyzes Immune Cells in Far More Detail: Technology Promises More Effective Prescription Drug Therapies



Garry Nolan stands near the mass cytometer, which his team helped develop. The instrument simultaneously measures several features of a cell, giving researchers an unprecedented ability to watch the processes taking place inside cells. (Credit: Norbert von der Groeben)

ScienceDaily (May 5, 2011) — Researchers at the Stanford University School of Medicine have taken a machine already in use for the measurement of impurities in semiconductors and used it to analyze immune cells in far more detail than has been possible before. The new technology lets scientists take simultaneous measurements of dozens of features located on and in cells, whereas the existing technology typically begins to encounter technical limitations at about a half-dozen.

The investigators were able not only to simultaneously categorize more immune cell types than ever before seen at once but, at the same time, to peer inside those cells and learn how various internal processes differed from one cell type to the next.

"We can tell not only what kind of cell it is, but essentially what it's thinking, what it's been doing, and what it may soon do or become," said Garry Nolan, PhD, professor of microbiology and immunology and the senior author of the study detailing the advance, to be published May 6 in *Science*.

With this new approach, the scientists were further able to show the unexpected effects of a drug recently approved for treating certain leukemias -- dasatinib -- on biochemical activities taking place inside various types of cells, offering a possible explanation for some of dasatinib's side effects as well as suggesting potential new uses for the drug.

In the study, Nolan and his colleagues simultaneously monitored 34 different substances found inside and on the surface of different cell types produced in human bone marrow, the place where all immune and blood cells, as well as blood disorders such as leukemia, originate.

By measuring large numbers of cell features all at once with the new technology -- called mass cytometry -- the team could capture subtle transitions between cell states in, essentially, a high-resolution snapshot of the entire blood-forming system, he said. Scientists normally think of the blood and immune cells as differentiating in a series of discrete steps. However, the authors showed that the transitions from one cell state to another are marked by gradually shifting levels of cell-surface markers and varying amounts and activation states of several intercellular molecules.

Mass cytometry builds on an established technology known as fluorescence-activated cell sorting, or FACS, which is in widespread use throughout the world. FACS was developed in the laboratory of Leonard Herzenberg, PhD, professor emeritus of genetics, under whose direction Nolan did his PhD work in the 1980s.

Both FACS and mass cytometry employ antibodies to specifically tag particular surface features on cells. With traditional FACS, antibodies are designed to tag diverse cell features. Then the antibodies are affixed to differently fluorescent dyes that color-code these antibodies according to which cell feature they target. After being bathed in these antibody-dye preparations, cells are passed single-file through a tube and stimulated by laser pulses, which cause the dye molecules to give off bursts of light. Different wavelengths of light emitted by the dyes correspond to the cellular features the dyes have tagged. FACS technology, though over 30 years old, is a mainstay of immune studies, as well as cancer and vaccine research.

But researchers are eager to squeeze ever more information out of each cell they examine. This requires examining ever more cell features at once, and there are only so many colors in the rainbow. The ability of FACS to distinguish between any more than a half-dozen dyes is constrained by those dyes' overlapping fluorescence patterns.

Three years ago, Nolan was approached by Scott Tanner, a physical chemist now at the University of Toronto.

"He buttonholed me at a meeting," said Nolan, laughing. "I was trying to get away from him, but after he'd been talking for a few minutes I realized this was something I'd better start paying attention to. He clearly had something that, if true, was revolutionary in its potential."

Tanner's team was adapting for biological purposes an existing instrument that is typically used for gauging precise levels of added rare-earth impurities in semiconductors and for geological purposes. The new instrument, called a mass cytometer, promised to more than double the number of molecular features that could be measured simultaneously in each cell. Nolan, realizing that such an instrument could be used to learn much more about the immune system and cancer stem cells, was eager to bring his group's expertise to bear on its development. The Stanford team has worked in close collaboration with the new instrument's developers ever since.

Instead of dyes, mass cytometry joins rare-earth metals to antibodies, which in turn detect cellular features and processes. "The rare earths are a series of 17 elements, mostly at the bottom of periodic table, that nobody wanted to learn about in chemistry class, myself included," said Sean Bendall, PhD, a postdoctoral researcher in Nolan's lab. However, these elements turn out to particularly useful for biological applications, said Bendall, who shared first authorship of the *Science* paper with Erin Simonds, a graduate student in Nolan's lab.

"They're not all that rare in nature, but they're normally never found in the body," Bendall said. "If I looked at a sample of your blood and found some europium or ytterbium or neodymium in it, I'd say you were in deep trouble." So rare-earth elements stand out in a crowd.

What's more, these elements can be subdivided into as many as 100 variants with distinct atomic weights. Mass cytometry can easily detect those differences. "We need relatively few rare-earth atoms per cell for our instrument to see them," said Bendall.

In mass cytometry, cells are paraded one by one through a tube and sprayed into a tiny chamber in which they are heated to about 13,000 degrees Fahrenheit and vaporized into successive clouds of atomic nuclei and loose electrons. Next, the contents of each cloud that was once a cell are essentially flung against a wall with equal force. The lightest atoms arrive first, then the next-lightest and so forth. A detector counts the atoms as they land, and from this the instrument can determine their mass. The mass tallies how many copies of each metal-tagged antibody were stuck to the cell and, therefore, how many copies of each molecular feature were present on, or in, the cell in the first place.

In the *Science* study, Nolan and his colleagues used the instrument to simultaneously monitor 13 separate molecular features on the surfaces of cells in samples taken from two healthy humans' bone marrow, and classified the cells into numerous distinct categories. The investigators simultaneously monitored activation states of 18 different intracellular protein targets. Protein activation levels give important clues about particular cellular decisions that have been or can be made, such as whether a cell is about to divide.

"As a prelude to looking at leukemic bone-marrow samples down the road, we wanted to first characterize the cells in normal bone marrow to see how their behaviors change as they mature," said Simonds.

The Nolan group perturbed cells by exposing them to various substances, including signaling molecules that sometimes circulate in our own blood, as well as foreign materials such as fragments of bacterial cell walls that are known to excite immune responses. "In essence," said Nolan, "we are interviewing or interrogating the cells, forcing them to reveal their inner thought processes." Some of these stimulatory tests were done in

the presence of dasatinib, a drug used to treat chronic myelogenous leukemia and certain cases of acute lymphoblastic leukemia. Dasatinib is in clinical trials for several other indications, including some solid cancers.
When the Nolan group used a chemical, pervanadate, to "release the brakes" on a universal pro-cell-survival behavior, dasatinib blocked action in every cell type except one, the immune sentinels called dendritic cells.
Simonds said this new finding demonstrates mass cytometry's capacity to ferret out tiny differences in cellular behavior that may help explain drugs' side effects as well as to indicate potential new uses for existing drugs.
The more measurements your tailor makes, the better the fit. It's the same with cell biology. "Our entire lab has already shifted from fluorescence-based measurements of cell features to this new MS-based method, because we get a much more complete picture," said Bendall.
Nolan has reported that he owns stock in the company Tanner created to develop and market the new system.
The study was sponsored by the National Heart, Lung and Blood Institute, the National Institute of Allergy and Infectious Diseases, the National Cancer Institute and the Leukemia & Lymphoma Society. Other Stanford co-authors are senior research scientist Peter Krutzik, PhD; postdoctoral researcher Karen Sachs, PhD; data analyst Rachel Finck; research assistant Angelica Trejo; graduate student Robert Bruggner; associate professor of radiology Sylvia Plevritis, PhD; and former postdoctoral researcher Peng Qiu, PhD, now an associate professor at the University of Texas-MD Anderson Cancer Center.

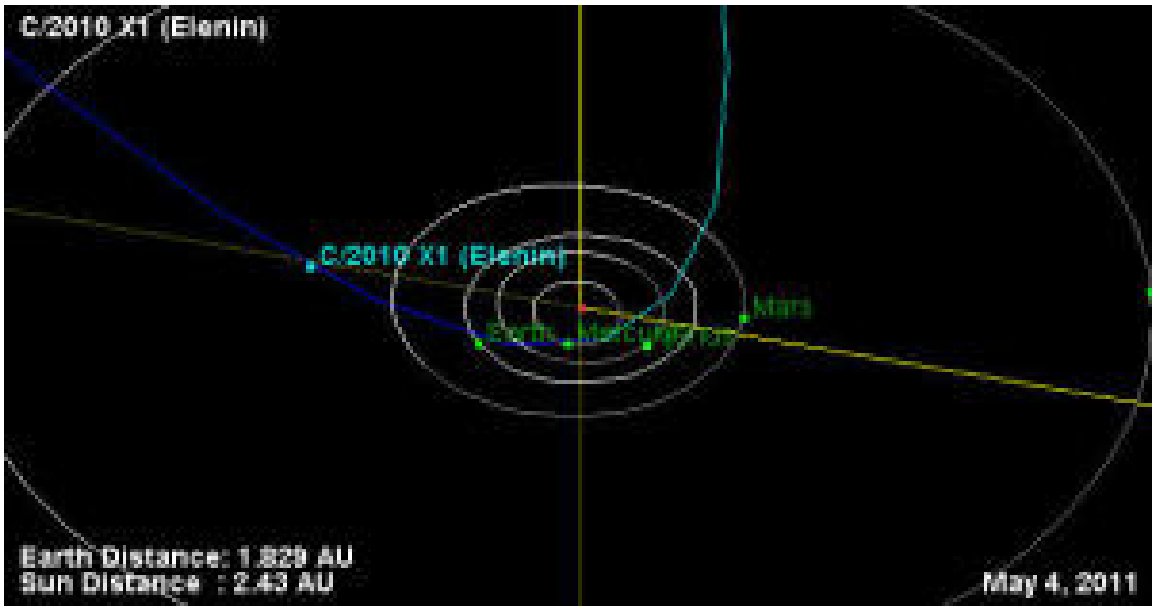
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Stanford University Medical Center**. The original article was written by Bruce Goldman.

Journal Reference:

1. Sean C. Bendall, Erin F. Simonds, Peng Qiu, El-Ad D. Amir, Peter O. Krutzik, Rachel Finck, Robert V. Bruggner, Rachel Melamed, Angelica Trejo, Olga I. Ornatsky, Robert S. Balderas, Sylvia K. Plevritis, Karen Sachs, Dana Pe'er, Scott D. Tanner, and Garry P. Nolan. **Single-Cell Mass Cytometry of Differential Immune and Drug Responses Across a Human Hematopoietic Continuum**. *Science*, 2011; 332 (6030): 687-696 DOI: 10.1126/science.1198704

http://www.sciencedaily.com/releases/2011/05/110505142602.htm

Comet Elenin: Preview of a Coming Attraction



Trajectory of comet Elenin. (Credit: NASA/JPL-Caltech)

ScienceDaily (May 6, 2011) — You may have heard the news: Comet Elenin is coming to the inner-solar system this fall.

Comet Elenin (also known by its astronomical name C/2010 X1), was first detected on Dec. 10, 2010 by Leonid Elenin, an observer in Lyubertsy, Russia, who made the discovery "remotely" using the ISON-NM observatory near Mayhill, New Mexico. At the time of the discovery, the comet was about 647 million kilometers (401 million miles) from Earth. Over the past four-and-a-half months, the comet has -- as comets do -- closed the distance to Earth's vicinity as it makes its way closer to perihelion (its closest point to the sun). As of May 4, Elenin's distance is about 274 million kilometers (170 million miles).

"That is what happens with these long-period comets that come in from way outside our planetary system," said Don Yeomans of NASA's Near-Earth Object Program Office at NASA's Jet Propulsion Laboratory in Pasadena, Calif. "They make these long, majestic, speedy arcs through our solar system, and sometimes they put on a great show. But not Elenin. Right now that comet looks kind of wimpy."

How does a NASA scientist define cometary wimpiness?

"We're talking about how a comet looks as it safely flies past us," said Yeomans. "Some cometary visitors arriving from beyond the planetary region -- like Hale-Bopp in 1997 -- have really lit up the night sky where you can see them easily with the naked eye as they safely transit the inner-solar system. But Elenin is trending toward the other end of the spectrum. You'll probably need a good pair of binoculars, clear skies, and a dark, secluded location to see it even on its brightest night."

Comet Elenin should be at its brightest shortly before the time of its closest approach to Earth on Oct. 16 of this year. At its closest point, it will be 35 million kilometers (22 million miles) from us. Can this icy interloper influence us from where it is, or where it will be in the future? What about this celestial object inspiring some shifting of the tides or even tectonic plates here on Earth? There have been some incorrect Internet speculations that external forces could cause comet Elenin to come closer.

"Comet Elenin will not encounter any dark bodies that could perturb its orbit, nor will it influence us in any way here on Earth," said Yeomans. "It will get no closer to Earth than 35 million kilometers [about 22 million miles]. "

"Comet Elenin will not only be far away, it is also on the small side for comets," said Yeomans. "And comets are not the most densely-packed objects out there. They usually have the density of something akin to loosely packed icy dirt.

"So you've got a modest-sized icy dirtball that is getting no closer than 35 million kilometers," said Yeomans. "It will have an immeasurably miniscule influence on our planet. By comparison, my subcompact automobile exerts a greater influence on the ocean's tides than comet Elenin ever will."
Yeomans did have one final thought on comet Elenin.
"This comet may not put on a great show. Just as certainly, it will not cause any disruptions here on Earth. But there is a cause to marvel," said Yeomans. "This intrepid little traveler will offer astronomers a chance to study a relatively young comet that came here from well beyond our solar system's planetary region. After a short while, it will be headed back out again, and we will not see or hear from Elenin for thousands of years. That's pretty cool."
NASA detects, tracks and characterizes asteroids and comets passing relatively close to Earth using both ground- and space-based telescopes. The Near-Earth Object Observations Program, commonly called "Spaceguard," discovers these objects, characterizes a subset of them, and predicts their paths to determine if any could be potentially hazardous to our planet.
JPL manages the Near-Earth Object Program Office for NASA's Science Mission Directorate in Washington, DC. JPL is a division of the California Institute of Technology in Pasadena.
More information about asteroids and near-Earth objects is at: http://www.jpl.nasa.gov/asteroidwatch

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/2011/05/110505125054.htm

Sticking Their Necks out for Evolution: Why Sloths and Manatees Have Unusually Long (or Short) Necks

Manatee. (Credit: © thier / Fotolia)

ScienceDaily (May 6, 2011) — As a rule all mammals have the same number of vertebrae in their necks regardless of whether they are a giraffe, a mouse, or a human. But both sloths and manatees are exceptions to this rule having abnormal numbers of cervical vertebrae. New research published in BioMed Central's open access journal *EvoDevo* shows how such different species have evolved their unusual necks.

Birds, reptiles and amphibians have varying number of vertebrae in their necks, swans have 22-25, but mammals, regardless of size of animal or the animal's neck, only have seven. Aberrant neck vertebrae are usually correlated with an increase in risk of stillbirth, childhood cancer and neuronal problems in mammals. These pleiotropic events are often associated with physical problems, such as thoracic outlet syndrome, due to misplaced or crushed nerves, muscles and blood vessels.

The only mammals which have evolved different numbers of neck vertebrae without any apparent problems are sloths and manatees. Two-toed sloths (Choloepus) have 5-7 neck vertebrae while three-toed sloths (Bradypus) have 8 or 9. There is some controversy over whether these changes are due to homeotic alteration, where mutation of a gene, such as Hox, causes incorrect skeletal patterning, or are due to an alteration in primaxial/abaxial patterning, where the thoracic structure overwrites that of the cervical vertebrae. Homeotic alteration would affect systems throughout the body and explains the associated effects seen in other mammals. Alteration in primaxial/abaxial patterning would only affect the vertebrae but may explain how sloths escape adverse effects.

After looking at evidence from sloths and related species such as anteaters and armadillos, none of which showed unusual neck structures, it became apparent that the conversion of vertebrae from cervical to thoracic for Choleopus suggested a complete foreshortening of the neck and there were ribs associated with the 7th vertebra. For C. hoffmanni these were complete ribs fused to the sternum, but for C. didactylus they were rudimentary ribs suggesting a transitional structure. In contrast, the 8th vertebra for Bradypus was still cervical and most resembled a normal 6th vertebra but the 9th vertebra had rudimentary ribs. None of these vertebrae patterns can be explained by alteration in primaxial/abaxial patterning. Furthermore other skeletal abnormalities were found in sloths including fusion of vertebrae, defective production of cartilage, ossification of sternum and pelvic girdle, abnormal fibrous bands connected to rudimentary ribs, and asymmetric ribs, which can only be explained as side effects of homeotic alteration.

Similarly the skeletons of manatees (Trichechus) were compared to dugongs and hyraxes. Manatee vertebrae and skeletons also showed similar alteration to the sloths. Surprisingly about half of the dugongs and a couple of the hyraxes studied also had reduced number of neck vertebrae and all of these had other skeletal abnormalities.
Dr Galis from the Netherlands Centre for Biodiversity Naturalis said, "Our research casts doubts on the validity of the aberrant primaxial/abaxial patterning theory and instead lends weight to Bateson's theory of homeotic transformation where the identity of the vertebrae has been changed from cervical to thoracic (or visa-versa depending on whether the neck if shorter as for Choloepus or longer as for Bradypus). The defects seen are most similar to mice with Hox mutations."
Dr Galis continued, "We think that it is the slow lifestyle and low metabolic rate which has allowed evolution to alter the neck length of sloths without any of the side effects seen for other mammals. Their low metabolic rates protect them from cancer and their low activity rates protect them from thoracic outlet syndrome." So, for a sloth, being slow allowed them to evolve unusual necks.

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

Journal Reference:

1. Irma Varela-Lasheras, Alexander J Bakker, Steven D van der Mije, Johan AJ Metz, Joris van Alphen and Frietson Galis. **Breaking evolutionary and pleiotropic constraints in mammals. On sloths, manatees and homeotic mutations**. *EvoDevo*, 2011; (in press) [link]

http://www.sciencedaily.com/releases/2011/05/110505212314.htm

Quantum Simulation With Light: Frustrations Between Photon Pairs

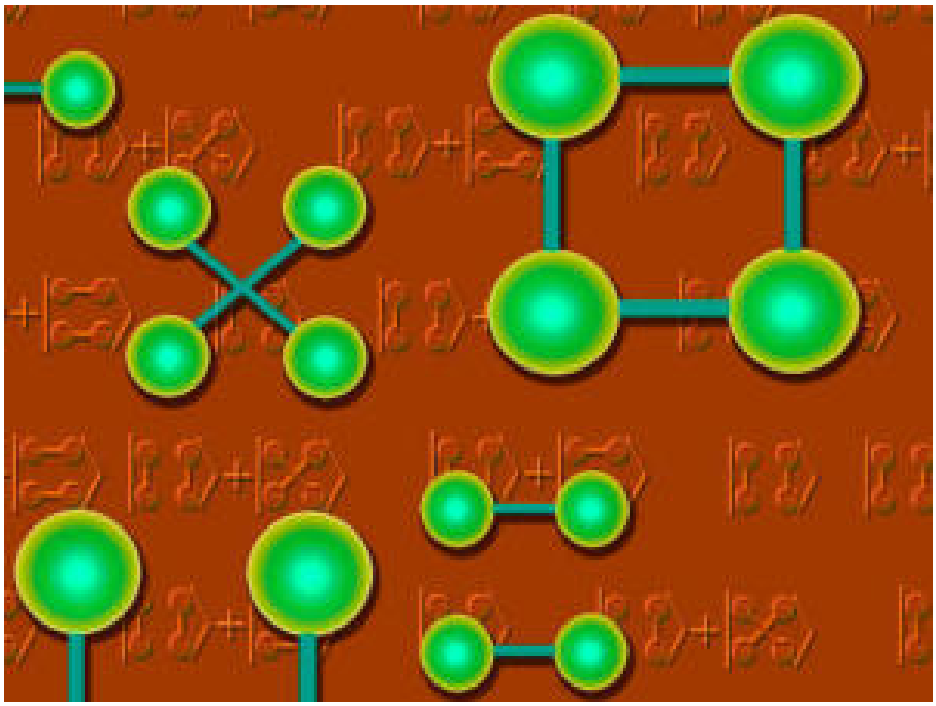


Illustration of pairs in a quantum mechanical system. (Credit: Felice Frankel)

ScienceDaily (May 6, 2011) — Researchers from the Vienna Center for Quantum Science and Technology at the University of Vienna and the Institute of Quantum Optics and Quantum Information (IQOQI) at the Austrian Academy of Sciences used a quantum mechanical system in the laboratory to simulate complex many-body systems. This experiment, which is published in *Nature Physics*, promises future quantum simulators with enormous potential insights into unknown quantum phenomena.

Already the behavior of relatively small quantum systems cannot be calculated because quantum states contain much more information than their classical counter-parts. However, if another quantum system is used to simulate the quantum system of interest, then answers about the properties of the complex quantum system can be obtained.

When is a quantum system frustrated?

Currently, many international groups are focusing their research on frustrated quantum systems, which have been conjectured to explain high-temperature superconductivity. A quantum system is frustrated if competing requirements cannot be satisfied simultaneously. The Viennese research group realized for the first time an experimental quantum simulation, where the frustration regarding the "pairing" of correlations was closely investigated.

Using two pairs of entangled photons, a frustrated quantum system could be simulated that consists of four particles. "Just the recent development of our quantum technology allows us to not only rebuild other quantum systems, but also to simulate its dynamics" says Philip Walther (University of Vienna). "Now we can prepare quantum states of individual photons to gain insights into other quantum systems," explains Xiao-song Ma (Austrian Academy of Sciences).Therefore, two in polarization entangled photons exhibit in many ways the same quantum physical properties as for example electrons in matter.

Conflict over partnerships

The research team of international scientists from China, Serbia, New Zeeland and Austria prepared single photons that were facing the conflict over partnerships between each other. Each photon can establish a single bond to only one partner exclusively, but wants to get correlated with several partners -- obviously this leads to frustration. As a result, the quantum system uses "tricks" that allow quantum fluctuations that different pairings can coexist as superposition.

The work of the Viennese group underlines that quantum simulations are a very good tool for calculating quantum states of matter and are thus opening the path for the investigation of more complex systems.

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

Journal Reference:

1. Xiao-song Ma, Borivoje Dakic, William Naylor, Anton Zeilinger, Philip Walther. **Quantum simulation of the wavefunction to probe frustrated Heisenberg spin systems**. *Nature Physics*, 2011; 7 (5): 399 DOI: 10.1038/nphys1919

http://www.sciencedaily.com/releases/2011/05/110505111942.htm

Forecast Calls for Nanoflowers to Help Return Eyesight: Physicist Leads Effort to Design Fractal Devices to Put in Eyes

Richard Taylor, physics professor and director of the University of Oregon Material Science Institute, is on a quest to grow flowers that will help people who've lost their sight by designing nano-sized flowers whose fractal shapes on implants will engage with neurons to carry light to the optic nerve. (Credit: Photo by Jim Barlow)

ScienceDaily (May 6, 2011) — University of Oregon researcher Richard Taylor is on a quest to grow flowers that will help people who've lost their sight, such as those suffering from macular degeneration, to see again. These flowers are not roses, tulips or columbines. They will be nanoflowers seeded from nano-sized particles of metals that grow, or self assemble, in a natural process -- diffusion limited aggregation. They will be fractals that mimic and communicate efficiently with neurons.

Fractals are "a trademark building block of nature," Taylor says. Fractals are objects with irregular curves or shapes, of which any one component seen under magnification is also the same shape. In math, that property is self-similarity. Trees, clouds, rivers, galaxies, lungs and neurons are fractals, Taylor says. Today's commercial electronic chips are not fractals, he adds.

Eye surgeons would implant these fractal devices within the eyes of blind patients, providing interface circuitry that would collect light captured by the retina and guide it with almost 100 percent efficiency to neurons for relay to the optic nerve to process vision.

In an article titled "Vision of beauty" for *Physics World*, Taylor, a physicist and director of the UO Materials Science Institute, describes his envisioned approach and how it might overcome the problems occurring with current efforts to insert photodiodes behind the eyes. Current chip technology is limited, because it doesn't allow sufficient connections with neurons.

"The wiring -- the neurons -- in the retina is fractal, but the chips are not fractal," Taylor says. "They are just little squares of electrodes that provide too little overlap with the neurons."

Beginning this summer, Taylor's doctoral student Rick Montgomery will begin a yearlong collaboration with Simon Brown at the University of Canterbury in New Zealand to experiment with various metals to grow the fractal flowers on implantable chips.

The idea for the project emerged as Taylor was working under a Cottrell Scholar Award he received in 2003 from the Research Corporation for Science Advancement. His vision is now beginning to blossom under grants from the Office of Naval Research (ONR), the U.S. Air Force and the National Science Foundation.

Taylor's theoretical concept for fractal-based photodiodes also is the focus of a U.S. patent application filed by the UO's Office of Technology Transfer under Taylor's and Brown's names, the UO and University of Canterbury.

The project, he writes in the *Physics World* article, is based on "the striking similarities between the eye and the digital camera." (*Physics World* article is available at: http://physicsworld.com/cws/article/indepth/45840) "The front end of both systems," he writes, "consists of an adjustable aperture within a compound lens, and advances bring these similarities closer each year." Digital cameras, he adds, are approaching the capacity to capture the 127 megapixels of the human eye, but current chip-based implants, because of their interface, are only providing about 50 pixels of resolution.

Among the challenges, Taylor says, is determining which metals can best go into body without toxicity problems. "We're right at the start of this amazing voyage," Taylor says. "The ultimate thrill for me will be to go to a blind person and say, we're developing a chip that one day will help you see again. For me, that is very different from my previous research, where I've been looking at electronics to go into computers, to actually help somebody … if I can pull that off that will be a tremendous thrill for me."

Taylor also is working under a Research Corp. grant to pursue fractal-based solar cells.

Story Source:

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

http://www.sciencedaily.com/releases/2011/05/110505181537.htm

Tree Rings Tell a 1,100-Year History of El Niño

Bristlecone trees, such as this over a thousand-year-old tree in the Great Basin National Park, contributed to the tree-ring record on El Niño. (Credit: Image courtesy International Pacific Research Center)

ScienceDaily (May 6, 2011) — El Niño and its partner La Niña, the warm and cold phases in the eastern half of the tropical Pacific, play havoc with climate worldwide. Predicting El Niño events more than several months ahead is now routine, but predicting how it will change in a warming world has been hampered by the short instrumental record. An international team of climate scientists has now shown that annually resolved tree-ring records from North America, particularly from the US Southwest, give a continuous representation of the intensity of El Niño events over the past 1100 years and can be used to improve El Niño prediction in climate models.

The study, spearheaded by Jinbao Li, International Pacific Research Center, University of Hawai'i at Manoa, is published in the May 6 issue of *Nature Climate Change*.

Tree rings in the US Southwest, the team found, agree well with the 150-year instrumental sea surface temperature records in the tropical Pacific. During El Niño, the unusually warm surface temperatures in the eastern Pacific lead to changes in the atmospheric circulation, causing unusually wetter winters in the US Southwest, and thus wider tree rings; unusually cold eastern Pacific temperatures during La Niña lead to drought and narrower rings. The tree-ring records, furthermore, match well existing reconstructions of the El Niño-Southern Oscillation and correlate highly, for instance, with $\delta^{18}O$ isotope concentrations of both living corals and corals that lived hundreds of years ago around Palmyra in the central Pacific.

"Our work revealed that the towering trees on the mountain slopes of the US Southwest and the colorful corals in the tropical Pacific both listen to the music of El Niño, which shows its signature in their yearly growth rings," explains Li. "The coral records, however, are brief, whereas the tree-ring records from North America supply us with a continuous El Niño record reaching back 1100 years."

The tree rings reveal that the intensity of El Niño has been highly variable, with decades of strong El Niño events and decades of little activity. The weakest El Niño activity happened during the Medieval Climate Anomaly in the 11th century, whereas the strongest activity has been since the 18th century.

These different periods of El Niño activity are related to long-term changes in Pacific climate. Cores taken from lake sediments in the Galapagos Islands, northern Yucatan, and the Pacific Northwest reveal that the eastern-central tropical Pacific climate swings between warm and cool phases, each lasting from 50 to 90 years. During warm phases, El Niño and La Niña events were more intense than usual. During cool phases, they deviated little from the long-term average as, for instance, during the Medieval Climate Anomaly when the eastern tropical Pacific was cool.

"Since El Niño causes climate extremes around the world, it is important to know how it will change with global warming," says co-author Shang-Ping Xie. "Current models diverge in their projections of its future behavior, with some showing an increase in amplitude, some no change, and some even a decrease. Our tree-ring data offer key observational benchmarks for evaluating and perfecting climate models and their predictions of the El Niño-Southern Oscillation under global warming."

This research was funded by the National Science Foundation, National Oceanic and Atmospheric Administration, Japan Agency for Marine-Earth Science and Technology, National Basic Research Program of China, and the National Natural Science Foundation of China.

Email or share this story:

| More

Story Source:

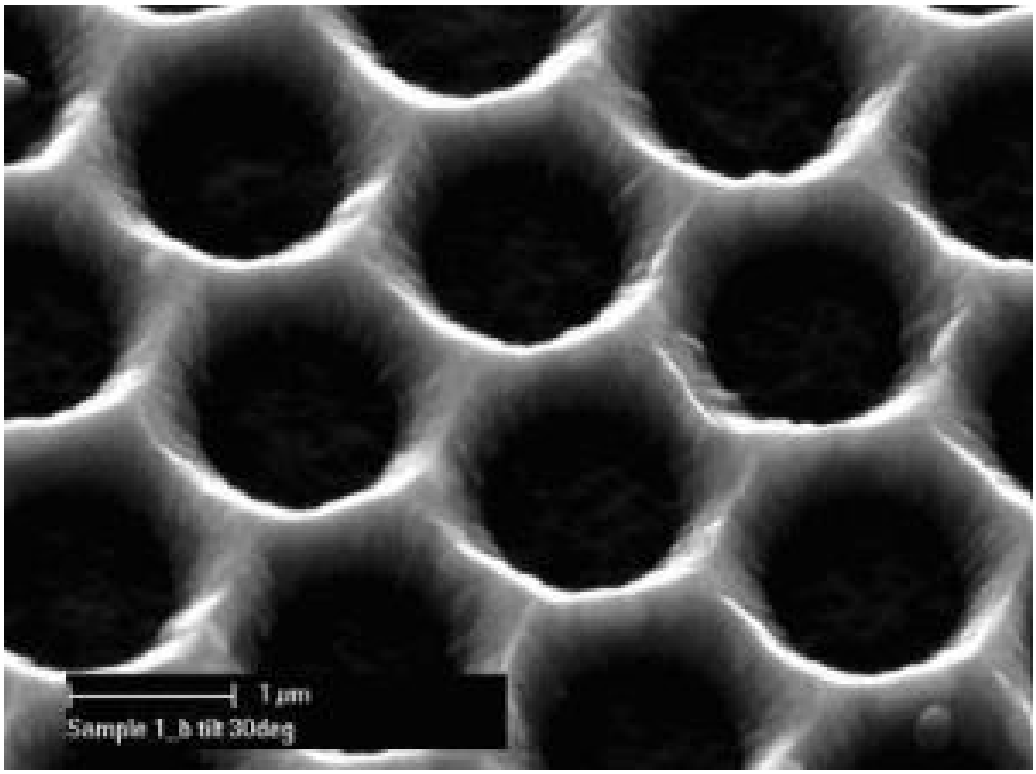
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of Hawaii at Manoa**, via EurekAlert!, a service of AAAS.

Journal Reference:

1. Jinbao Li, Shang-Ping Xie, Edward R. Cook, Gang Huang, Rosanne D'Arrigo, Fei Liu, Jian Ma, Xiao-Tong Zheng. **Interdecadal modulation of El Niño amplitude during the past millennium**. *Nature Climate Change*, 2011; 1 (2): 114 DOI: 10.1038/nclimate1086

http://www.sciencedaily.com/releases/2011/05/110506093107.htm

'Swiss Cheese' Design Enables Thin Film Silicon Solar Cells With Potential for Higher Efficiencies



This SEM micrograph shows the nanostructured ZnO layer, Swiss cheese design for Micromorph solar cells. (Credit: Milan Vanecek, Institute of Physics, Prague)

ScienceDaily (May 6, 2011) — A bold new design for thin film solar cells that requires significantly less silicon -- and may boost their efficiency -- is the result of an industry/academia collaboration between Oerlikon Solar in Switzerland and the Institute of Physics' photovoltaic group at the Academy of Sciences of the Czech Republic.

One long-term option for low-cost, high-yield industrial production of solar panels from abundant raw materials can be found in amorphous silicon solar cells and microcrystalline silicon tandem cells (a.k.a. Micromorph) -- providing an energy payback within a year.

A drawback to these cells, however, is that the stable panel efficiency is less than the efficiency of presently dominate crystalline wafer-based silicon, explains Milan Vanecek, who heads the photovoltaic group at the Institute of Physics in Prague.

"To make amorphous and microcrystalline silicon cells more stable they're required to be very thin because of tight spacing between electrical contacts, and the resulting optical absorption isn't sufficient," he notes. "They're basically planar devices. Amorphous silicon has a thickness of 200 to 300 nanometers, while microcrystalline silicon is thicker than 1 micrometer."

The team's new design focuses on optically thick cells that are strongly absorbing, while the distance between the electrodes remains very tight. They describe their design in the American Institute of Physics' journal *Applied Physics Letters*.

"Our new 3D design of solar cells relies on the mature, robust absorber deposition technology of plasma-enhanced chemical vapor deposition, which is a technology already used for amorphous silicon-based electronics produced for liquid crystal displays. We just added a new nanostructured substrate for the deposition of the solar cell," Vanecek says.

This nanostructured substrate consists of an array of zinc oxide (ZnO) nanocolumns or, alternatively, from a "Swiss cheese" honeycomb array of micro-holes or nano-holes etched into the transparent conductive oxide layer (ZnO).

"This latter approach proved successful for solar cell deposition," Vanecek elaborates. "The potential of these efficiencies is estimated within the range of present multicrystalline wafer solar cells, which dominate solar cell industrial production. And the significantly lower cost of Micromorph panels, with the same panel efficiency as multicrystalline silicon panels (12 to 16 percent), could boost its industrial-scale production." The next step is a further optimization to continue improving efficiency.

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

Journal Reference:

1. Milan Vanecek, Oleg Babchenko, Adam Purkrt, Jakub Holovsky, Neda Neykova, Ales Poruba, Zdenek Remes, Johannes Meier, Ulrich Kroll. **Nanostructured three-dimensional thin film silicon solar cells with very high efficiency potential**. *Applied Physics Letters*, 2011; 98 (16): 163503 DOI: 10.1063/1.3583377

http://www.sciencedaily.com/releases/2011/05/110506165312.htm

Robot Engages Novice Computer Scientists

Finch Robot. (Credit: Image courtesy of Carnegie Mellon University)

ScienceDaily (May 5, 2011) — Learning how to program a computer to display the words "Hello World" once may have excited students, but that hoary chestnut of a lesson doesn't cut it in a world of videogames, smartphones and Twitter. One option to take its place and engage a new generation of students in computer programming is a Carnegie Mellon University-developed robot called Finch.

A product of CMU's famed Robotics Institute, Finch was designed specifically to make introductory computer science classes an engaging experience once again.

A white plastic, two-wheeled robot with bird-like features, Finch can quickly be programmed by a novice to say "Hello, World," or do a little dance, or make its beak glow blue in response to cold temperature or some other stimulus. But the simple look of the tabletop robot is deceptive. Based on four years of educational research sponsored by the National Science Foundation, Finch includes a number of features that could keep students busy for a semester or more thinking up new things to do with it.

"Students are more interested and more motivated when they can work with something interactive and create programs that operate in the real world," said Tom Lauwers, who earned his Ph.D. in robotics at CMU in 2010 and is now an instructor in the Robotics Institute's CREATE Lab. "We packed Finch with sensors and mechanisms that engage the eyes, the ears -- as many senses as possible."

Lauwers has launched a startup company, BirdBrain Technologies, to produce Finch and now sells them online at www.finchrobot.com for $99 each.

"Our vision is to make Finch affordable enough that every student can have one to take home for assignments," said Lauwers, who developed the robot with Illah Nourbakhsh, associate professor of robotics and director of the CREATE Lab. Less than a foot long, Finch easily fits in a backpack and is rugged enough to survive being hauled around and occasionally dropped.

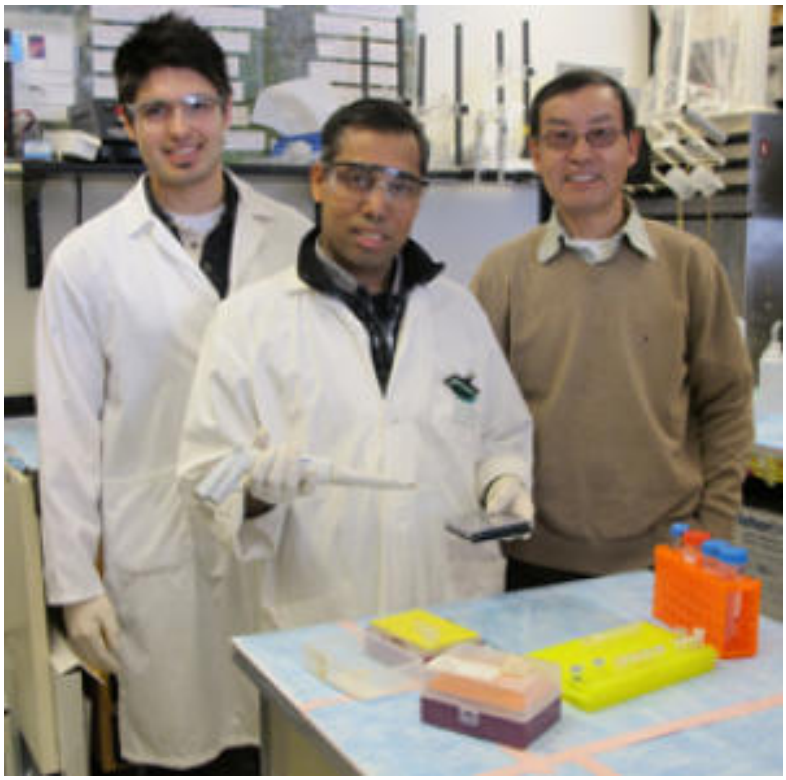
Finch includes temperature and light sensors, a three-axis accelerometer and a bump sensor. It has color-programmable LED lights, a beeper and speakers. With a pencil inserted in its tail, Finch can be used to draw pictures. It can be programmed to be a moving, noise-making alarm clock. It even has uses beyond a robot; its accelerometer enables it to be used as a 3-D mouse to control a computer display.

Robot kits suitable for students as young as 12 are commercially available, but often cost more than the Finch, Lauwers said. What's more, the idea is to use the robot to make computer programming lessons more interesting, not to use precious instructional time to first build a robot.
Finch is a plug-and-play device, so no drivers or other software must be installed beyond what is used in typical computer science courses. Finch connects with and receives power from the computer over a 15-foot USB cable, eliminating batteries and off-loading its computation to the computer. Support for a wide range of programming languages and environments is coming, including graphical languages appropriate for young students. Finch currently can be programmed with the Java and Python languages widely used by educators.
A number of assignments are available on the Finch Robot website to help teachers drop Finch into their lesson plans, and the website allows instructors to upload their own assignments or ideas in return for company-provided incentives. The robot has been classroom-tested at the Community College of Allegheny County, Pa., and by instructors in high school, university and after-school programs.
"Computer science now touches virtually every scientific discipline and is a critical part of most new technologies, yet U.S. universities saw declining enrollments in computer science through most of the past decade," Nourbakhsh said. "If Finch can help motivate students to give computer science a try, we think many more students will realize that this is a field that they would enjoy exploring."

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

http://www.sciencedaily.com/releases/2011/05/110505142736.htm

Hunting for Deadly Bacteria



Professor Yingfu Li (far right) with two of his research team members, Sergio Aguirre (left) and Monsur Ali (centre), whose recently published paper in the Angewandte Chemie journal discusses research that will help detect deadly food-borne bacteria. (Credit: Image courtesy of McMaster University)

ScienceDaily (May 5, 2011) — You can't see them, or smell them or taste them. They can be in our water and in our food, multiplying so rapidly that conventional testing methods for detecting pathogens such as E.coli, Salmonella and Listeria come too late for the tens of thousands of Canadians who suffer the ill effects of these deadly bacteria.

Biochemist Yingfu Li and his research team have developed a simple test that can swiftly and accurately identify specific pathogens using a system that will 'hunt' for bacteria, identifying their harmful presence before they have a chance to contaminate our food and water.

Like any living thing, bacteria have their own spoor, leaving behind DNA trails of bacterial 'droppings'. Li tracks these metabolic by-products with molecular beacons -- little lighthouses on a molecular scale that actually light up when they detect the DNA sequence left behind.

Li created a DNAzyme sensor that will be able to identify any bacteria, utilizing a method that doesn't require the steps and specialized equipment typically used to identify whether or not harmful bacteria are present.

"Current methods of foodborne bacterial detection take time. The five days it takes to detect listeria, for example, can translate into an outbreak that costs lives. We have developed a universal test that uses less complex procedures but still generates precise and accurate results," says Li, a Canada Research Chair in Directed Evolution of Nucleic Acids.

Li's fluorescent test system was highlighted in *Angewandte Chemie International Edition*. Li's paper, co-authored with lab members Monsur Ali, Sergio Aguirre and Hadeer Lazim, was designated a 'hot paper' by Angewandte's editors for its "importance in a rapidly evolving field of current interest."

"McMaster researchers are known for their ability to provide solutions to problems that impact the public's well-being. The test that Professor Li has developed will help safeguard the health of Canadians, and supply industry with a reliable means to bring safe food products to consumers and reduce their time to market," said Mo Elbestawi, vice-president, research and international affairs.

Li's research was funded by the Natural Sciences and Engineering Research Council (NSERC) and the Sentinel Bioactive Paper Network.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **McMaster University**. The original article was written by Danelle D'Alvise.

Journal Reference:

1. M. Monsur Ali, Sergio D. Aguirre, Hadeer Lazim, Yingfu Li. **Fluorogenic DNAzyme Probes as Bacterial Indicators**. *Angewandte Chemie International Edition*, 2011; 50 (16): 3751 DOI: 10.1002/anie.201100477

http://www.sciencedaily.com/releases/2011/04/110412143238.htm

What Secrets Do Ancient Medical Texts Hold?

The Smithsonian's Alain Touwaide studies ancient books to identify medicines used thousands of years ago

- By Megan Gambino
- *Smithsonian* magazine, May 2011

In 2002, Alain Touwaide came across an article about the discovery, some years before, of a medical kit salvaged from a 2,000-year-old shipwreck off the coast of Tuscany. Divers had brought up a copper bleeding cup, a surgical hook, a mortar, vials and tin containers. Miraculously, inside one of the tins, still dry and intact, were several tablets, gray-green in color and about the size of a quarter.

Touwaide, a science historian in the botany department at the National Museum of Natural History, recognized that the tablets were the only known samples of medicine preserved since antiquity. “I was going to do everything I could to get them,” he says.

Touwaide, 57, has devoted his career to unearthing lost knowledge. He is proficient in 12 languages, including ancient Greek, and he scours the globe searching for millennia-old medical manuscripts. Within their pages are detailed accounts and illustrations of remedies derived from plants and herbs.

After 18 months of negotiations, Touwaide obtained two samples of the 2,000-year-old tablets from Italy’s Department of Antiquities. He then recruited Robert Fleischer, head geneticist at the Smithsonian’s Center for Conservation and Evolutionary Genetics, to identify plant components in the pills. Fleischer was skeptical at first, figuring that the plants’ DNA was long degraded. “But once I saw plant fibers and little bits of ground-up plant material in close-up images of the tablets, I started to think maybe these really are well preserved,” he says.

Over the past seven years, Fleischer has painstakingly extracted DNA from the samples and compared it with DNA in GenBank, a genetic database maintained by the National Institutes of Health. He has found traces of carrot, parsley, alfalfa, celery, wild onion, radish, yarrow, hibiscus and sunflower (though he suspects the sunflower, which botanists consider a New World plant, is a modern contaminant). The ingredients were bound together by clay in the tablets.

Armed with Fleisher’s DNA results, Touwaide cross-referenced them with mentions of the plants in early Greek texts including the *Hippocratic Collection*—a series loosely attributed to Hippocrates, the father of Western medicine. Touwaide found that most of the tablets’ ingredients had been used to treat gastrointestinal

disorders, which were common among sailors. Afflicted seafarers, Touwaide speculates, might have diluted the tablets in wine, vinegar or water to ingest them.

This latest research will be added to the holdings of the Institute for the Preservation of Medical Traditions—a nonprofit organization founded by Touwaide and his wife and colleague, Emanuela Appetiti, a cultural anthropologist.

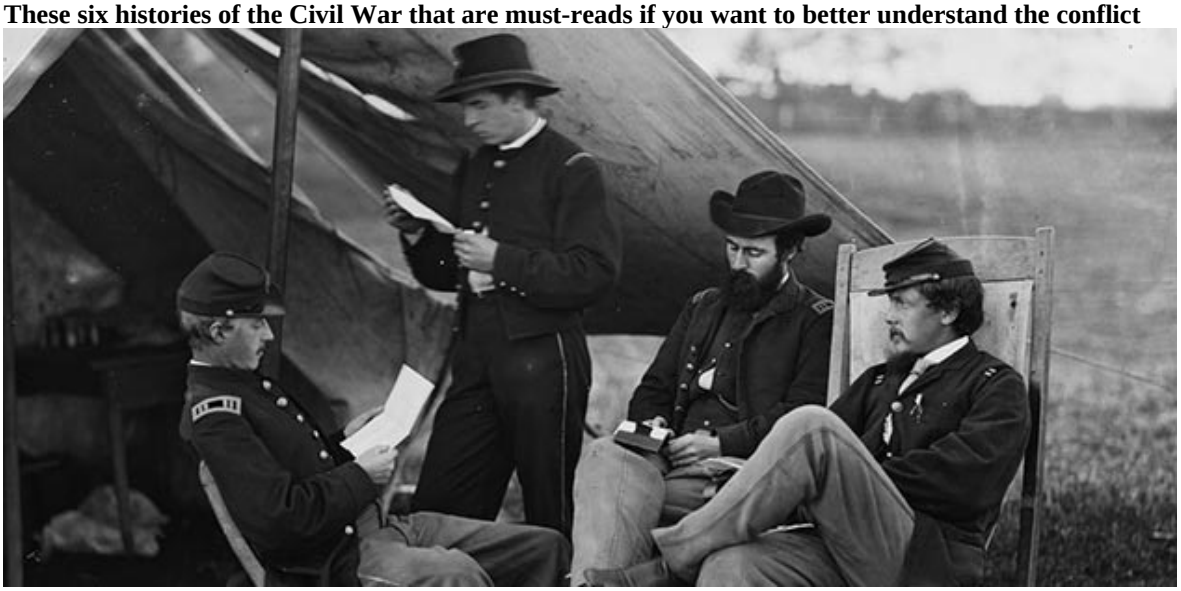
"The knowledge to do what I'm doing is disappearing," says Touwaide, surrounded by his 15,000 volumes of manuscripts and reference books, collectively named *Historia Plantarum* ("History of Plants"). With manuscripts deteriorating and fewer students learning ancient Greek and Latin, he feels a sense of urgency to extract as much information as possible from the ancient texts. He says they tell stories about the lives of ancient physicians and trade routes and contain even such esoterica as an ancient system for describing colors.

"This is important work," says Fleischer. "He is trying to tie all this together to get a broader picture of how people in ancient cultures healed themselves with plant products."

Find this article at:
http://www.smithsonianmag.com/arts-culture/What-Secrets-Do-Ancient-Medical-Texts-Hold.html

The Essentials: Six Books on the Civil War

These six histories of the Civil War that are must-reads if you want to better understand the conflict



- By T.A. Frail
- Smithsonian.com, April 20, 2011

The literature on the war is so vast you could spend a lifetime reading really good books about it. Here are six excellent ones:
Battle Cry of Freedom (1988), by James McPherson: Widely regarded as the most authoritative one-volume history of the war.
The Fiery Trial (2010), by Eric Foner: A new Pulitzer-Prize-winning and authoritative account of President Abraham Lincoln's navigation through the politics of abolition; it won the Pulitzer Prize for History.
This Republic of Suffering: Death and the American Civil War (2008), by Drew Gilpin Faust: A moving examination of the ways in which the slaughter changed Americans' ideas on mortality and influenced the way they chose to remember the war.
Personal Memoirs of U.S. Grant (1885): it "surpasses any other military memoir of the Civl War and stands alone as the best presidential autobiography every published," says Joan Waugh, author of *U.S. Grant: American Hero, American Myth* (2009), itself a fine biography.
Robert E. Lee: A Biography (1934-35), by Douglas Southall Freeman: A portrait of the man in full four volumes on the leader of the Army of Northern Virginia.
Mary Chesnut's Civil War (1981), edited by C. Vann Woodward: a collection of writings, in diary form, of the doyenne whose sharp eye and tart tongue left an indelible impression of civilian life in the South during the war years.

Find this article at:
http://www.smithsonianmag.com/history-archaeology/The-Essentials-Six-Books-on-the-Civil-War.html

Five roboethical principles – for humans

- 09 May 2011 by **Alan Winfield**

Magazine issue 2811.

(Image: Don Farrall/GETTY)

Science fiction primes us to expect robots to run amok. But as they go mainstream, it's still us that need policing

IT IS the year 2015. Engineers Gregory Powell and Mike Donovan, plus a robot nicknamed Speedy, are on Mercury to restart operations at an abandoned mining station. The men are field specialists for the United States Robots and Mechanical Men Corporation, employed mainly to test new or experimental robots. Unluckily, their base's photo-cell banks are low on selenium and the nearest source is 27 kilometres away. Since Speedy is the only one of the three that can withstand Mercury's temperatures, Donovan sends it out to get some. But when Speedy has not returned after 5 hours, Powell and Donovan become uneasy. They finally locate the robot moving in a circle around a selenium pool, with a peculiar stagger. Asked to return, Speedy responds: "Hot dog, let's play games. You catch me and I catch you..." and starts quoting Gilbert and Sullivan. In short, Speedy is acting like a human drunk.

Eventually, Powell realises that chemicals near the pool are destabilising the robot. Normally, Speedy would follow the rule that a robot must obey orders, but because it was expensive to manufacture, its level of adherence to another rule, that a robot must protect its own existence, was strengthened.

As the order to retrieve the selenium was casually worded, with no emphasis on returning, Speedy cannot decide whether to obey the order or protect itself from danger. Further away from the selenium, the "obey" order outweighs the need for self-preservation, while closer in the self-preservation rule is stronger. The clash causes a feedback loop which confuses Speedy to the point that it starts acting drunk.

Every attempt to get Speedy out of the loop fails as its conflicted positronic brain cannot accept new orders. All that happens is that Speedy changes its route until it finds a new place where there is an equilibrium between avoiding danger and following orders, ending up just as confused. The only thing that might trump both rules is a third rule: that a robot may not allow a human being to come to harm by its inaction. Powell

risks his life by going out in the heat, hoping the no-harm-to-humans rule will overcome Speedy's cognitive dissonance and force the robot to rescue him. Luckily, the plan works.

That is the plot of the 1942 story *Runaround*, in which Isaac Asimov explicitly states his Three Laws of Robotics for the first time. These are: First Law, a robot may not injure a human being or, through inaction, allow a human being to come to harm; Second Law, a robot must obey any orders given to it by humans, except where such orders would conflict with the first law; Third Law, a robot must protect its own existence as long as such protection does not conflict with the first or second law.

Real robotics is a science born out of fiction. For roboticists this is both a blessing and a curse. It is a blessing because science fiction provides inspiration, motivation and thought experiments; a curse because most people's expectations of robots owe much more to fiction than reality. And because the reality is so prosaic, we roboticists often find ourselves having to address the question of why robotics has failed to deliver when it hasn't, especially since it is being judged against expectations drawn from fiction.

It's hardly surprising that the public debate on robot ethics is also confused, ranging from fantasy questions about when robots should have "rights", to fears of robot takeovers bringing about the end of humankind, to well-founded concerns about cyborgs becoming more like robots, and serious questions about the moral dimensions of using robots to care for children or old people, and unease over military robotics.

Making sense of all this is not easy. But if real-world robots are not much smarter than washing machines, why worry? The answer is precisely because today's robots are so dumb - more artificially stupid than artificially intelligent. But something big is happening in robotics. For the past 30 years, relatively unintelligent robots served industry well. The second wave of robotics involves mobile robots and, importantly, ones that have to work alongside humans. This next generation must be able to interact safely and reliably with people in unstructured and unpredictable environments like homes, hospitals and offices.

This was why the UK's Engineering and Physical Sciences Research Council and Arts and Humanities Research Council convened a "summit" last year to discuss social, legal and ethical issues in robotics. The idea was to produce a draft document to stimulate debate among roboticists and the public.

In drafting it, we took Asimov's Three Laws of Robotics as our starting point because they have cultural significance. Our big departure was in deciding that it was the ethics of the roboticists, not the robots, that we needed to worry about. After all, robots are not people: there's little point worrying about how a robot can be ethical, moral or responsible, no matter how interesting this might be. We also decided that we would only concern ourselves with existing robots and those five to 10 years away from being built, not the super-smart robots of some imagined future.

So how do Asimov's laws look, updated for 2011? Instead of Three Laws of Robotics, we have devised a Five Ethics for Roboticists, which are aimed at researchers, designers, manufacturers, suppliers and maintainers of robots. These are: First Ethic, robots are multi-use tools, and should not be designed solely or primarily to kill or harm humans, except in the interests of national security; Second Ethic, humans, not robots, are responsible agents, so robots should be designed and operated as far as is practicable to comply with existing laws and fundamental human rights and freedoms, including privacy; Third Ethic, robots are products which should be designed using processes which assure their safety and security; Fourth Ethic, robots are manufactured artefacts, so they should not be designed in a deceptive way to exploit vulnerable users (their machine nature should be transparent); Fifth Ethic, it should always be possible to find out who is legally responsibility for a robot.

Importantly, these "ethics" downplay the specialness of robots, treating them as tools and products to be designed and operated within legal and technical standards. The fourth ethic is the only one to explicitly address a quality of some robots: that of inducing emotional bonds or dependencies in humans. We think that designers or manufacturers should not exploit such dependencies, and that it should always be possible, as Toto did in *The Wizard of Oz*, to pull the curtain aside to expose the robot behind.

But despite our attempts to be practical, our ethical principles continue to be the object of controversy and dissent, both among summit delegates and those who have read the draft document. For example, should the first ethic be qualified by "except in the interests of national security"? I would say no, but excluding such a rider would instantly make these ethics irrelevant to the huge military robotics industry.

There are also criticisms that we have oversimplified a complex field, reducing it to sound bites, and some researchers point out that the Five Ethics raise more questions than they answer. They are right, but then, this is exactly the kind of debate we want to foster.

While our initiative is new, serious work on roboethics - a term coined in 2004 by Gianmarco Veruggio, lead author of the *European Robotics Research Network Roboethics Roadmap* - is not. Several countries have drafted ethical or standards frameworks for robotics, notably South Korea and Japan, and there is a growing literature on autonomous robot weapons. However, much of it focuses on the safety, accountability and even morality of robots' behaviour. Our initiative focuses more on the here-and-now responsibilities of roboticists, and we believe that is what makes it important.

Profile

Alan Winfield is Hewlett-Packard professor of electronic engineering and director of the science communication unit at the University of the West of England, Bristol, UK. The full robotics ethics draft discussion document, with commentary, is at bit.ly/jWclPj

http://www.newscientist.com/article/mg21028111.100-five-roboethical-principles--for-humans.html?full=true&print=true

Encouragement Boosts Minority Student Success

A tiny bit of encouragement at the front end of college proved stunningly effective in paring the minority achievement gap in one experiment.

By Daisy Grewal

A psychology experiment at Stanford shows that giving encouragement early on goes a long way toward minority students' academic performance. (Chris Futcher / istockphoto.com)

The achievement gap between black and white students has frustrated educators and policymakers alike for decades. Although the number of black students at American colleges has reached an all-time high, less than half of those students are expected to make it to graduation. Stanford psychologists Greg Walton and Geoff Cohen believe one way to help close the gap is to change the way students think about school.

In a recently published paper in *Science*, they explain how an intervention lasting only one hour boosted the grades of minority students over three years and cut the racial achievement gap in half.

The intervention itself was simple. A group of black and white college freshmen at a U.S. campus were brought together for a discussion about college life. These freshmen read essays written by both black and white senior students at the school. In the essays, the seniors wrote about the types of problems they faced when they first got to campus, such as getting snubbed by a professor or feeling lonely. Importantly, their essays emphasized how these problems tended to get better over time. After reading these essays, the freshmen wrote their own essays about how difficulties adjusting to college are normal and temporary. The entire exercise took only one hour.

For the next three years Walton and Cohen tracked the performance of this group of students, along with another group who had not received the intervention. The intervention had no effect on white students. However, the black students who participated ended up earning much higher grades compared to their peers of the same race. About 22 percent of them made it into the top quarter of their graduating class, compared to only 5 percent of the black students who had not participated. Overall, the intervention reduced the gap between white and black students by a staggering 52 percent.

Meanwhile, half the black students who didn't receive the intervention finished in the bottom 25 percent of their class, while only 33 percent of the black students who received it finished in the bottom quarter. Not only that, the black students who received the intervention reported feeling happier about their lives and having fewer health problems than their peers.

While it might seem like magic, the intervention's outsize success is less surprising as you learn the psychology behind it. Black students are largely outnumbered on most U.S. college campuses. These small

numbers, combined with negative stereotypes, can leave them feeling isolated and uncertain of themselves. The same goes for other groups who have historically faced prejudice and discrimination, such as Latinos and women in math and engineering.

"Everyone worries at first about whether they belong," says Walton, "but for students from groups that have been negatively stereotyped, their worries are more pervasive." Walton and Cohen's intervention helps assure these students that they do, in fact, belong in college.

To figure out exactly how the intervention helps, Walton and Cohen had the students keep a diary for a week. These diaries showed that the intervention changed how students thought about stressful situations, such as receiving a poor grade or not being invited to a party. Instead of taking such events personally, the students were able to brush them off and keep going.

"What the intervention does is provide people with an alternative interpretation to negative events," Walton explains. "It changes their perspective, so when their friends don't invite them somewhere, they don't take it to mean that they don't belong in general." Walton and Cohen also found that the students receiving the intervention were more likely to take risks that lead to personal growth, such as seeking out new friendships.

Other research confirms that brief psychological interventions can dramatically improve student performance. For example, a different study led by Cohen randomly assigned half the members of a seventh-grade class to spend 15 minutes writing an essay about a value that's important to them. Writing the essay had no effect on the grades of white students, but it significantly improved the grades of the black students over the course of a semester.

Cohen refers to the essay-writing task as a "self-affirmation" exercise, and it's thought to work by increasing feelings of self-worth. Greater feelings of self-worth lead students (and others) to work harder and pay less attention to setbacks.

While critics might say that these interventions gloss over other important causes of the racial achievement gap, Walton and Cohen fully acknowledge that their research offers no quick fixes.

"It's really important to understand the complicated sources that contribute to inequality," says Walton. "For example, if you go to a school where the teachers are less qualified, you'll be less prepared academically. Minority students tend to have more of those experiences."

While addressing problems in the educational system remains important, Walton believes that we should also address the psychological reasons that minority students perform poorly. He believes that removing psychological barriers may increase the likelihood that traditional solutions, such as improving curriculum, will yield positive results.

But before schools start applying these interventions more widely, there are a few issues they should consider. First, timing is very important. The intervention is most likely to work when it is given at the beginning of the academic year, before students experience the negative events that cause them to question themselves.

Second, the intervention needs to be subtle. If it's delivered in a way that's too obvious, minority students may feel like they are being singled out because of their race. And finally, researchers and school administrators need to work side by side in making sure the intervention is delivered effectively. For example, if students are simply told that problems adjusting to college are temporary, they may not really believe it. Instead of telling students this, Walton and Cohen had the students write essays about why this message is true. This encouraged them to adopt the message as their own.

Aside from informing educational policy, Walton and Cohen's research offers another important insight: it challenges the common belief that academic performance reflects stable, underlying abilities. In other words, their research raises important questions about whether grades and test scores accurately reflect people's abilities, given that both tend to underestimate the full potential of minority students.

As Walton points out, "We sometimes have this assumption that intellectual success is fixed and says something deep or true about somebody, for example, thinking that your SAT is diagnostic of your ability. This research shows how much people's performance can vary due to subtle, psychological manipulations."

http://www.miller-mccune.com/education/encouragement-boosts-minority-student-success-30976/?utm_source=Newsletter160&utm_medium=email&utm_content=0510&utm_campaign=newsletters

Lee Baca Wants to Educate L.A.'s Prisoners

In this Miller-McCune Q&A, Los Angeles County's top cop Lee Baca explains why he wants to offer an education to tens of thousands of prisoners.

By Vince Beiser

Sheriff Lee Baca is working with L.A.-area academics to figure out the best ways to develop and deliver a range of non-mandatory educational and vocational programs for inmates. (Christopher Dibble)

Los Angeles County Sheriff Lee Baca wants to teach criminals a lesson — literally.

The top cop of America's most populous county is launching a new initiative aimed at offering education to every one of the 160,000 inmates who pass through his lockups each year. Liberal reformers have long advocated such a course, citing studies showing lower recidivism rates among prisoners who learn while locked up. But it's extraordinary talk coming from the man who runs America's biggest jail system.

Baca's Education-Based Incarceration initiative officially launched last year but is still in the planning stages. The sheriff's staff is working with academics from UCLA, Occidental College, University of La Verne, California State University, Los Angeles, and California State University, Long Beach, to figure out the best ways to develop and deliver a range of non-mandatory educational and vocational programs for inmates.

Miller-McCune sat down with Baca in his Los Angeles office to discuss the pros of educating cons.

Miller-McCune: The idea is for every inmate that comes through your jails to have some kind of educational experience?

Lee Baca: Correct.

That's pretty ambitious. What brought you to that idea?

What brought me to the idea were the realities of managing the largest county jail system in the United States, which feeds the largest state prison system in the United States. We have a 70 percent recidivism rate in state prisons. The question is, "Why is recidivism in California rampantly out of control?" And the simple answer is that if you incarcerate the body and the mind combined, you're basically protecting society while they're in prison, but you're not doing much when they get out. Because it's the mind that is the ultimate tool of success. Ninety percent of jail inmates will get out. They have to be better prepared while they're being incarcerated to think differently about the free world and their choices.

Given what they cost the taxpayers in terms of crime and incarceration combined, I'm astounded that the public isn't clamoring for efficient educational opportunities in prisons. You can't do much about a deranged

predator type. You can give them all the education in the world, but if they're a predator, they're a predator. But that's not even 1 percent of the jail population.

Now, the theory of incarceration has always been punitive in America. Lock 'em up, throw the key away. I'm very pro-punitive. I'm not suggesting changing any of the punitive components. But the experiences we've had with people who are incarcerated is that 90 percent are hungry for new knowledge. That's the point. They're willing to acknowledge their limitations in thinking. They flat-out are a very good student population.

When you talk about education, what do you mean specifically?

I'm talking about literacy, math, geometric skills. I'm talking about anthropology, psychology, history, philosophy, religion, grammar, spelling … any element of knowledge. Now, I talk to a lot of parolees and incarcerated people. They stumbled along the way of traditional elementary and middle and high school. So we've got this system we're working on that will evaluate their educational achievements as they enter the system and start addressing deficits in it.

We don't have enough teachers. So we're using technology as one of the tools. We're planning to use the cell as a classroom and technology as the teacher.

What kind of technology?

We're looking at DVDs, closed-circuit TVs running educational programming from the Discovery Channel, self-instruction booklets, computers you can't get on the Internet with, MP3 players with prerecorded lectures. And we're looking at using inmates and staff as mentors.

It's self-selected subject matter. They take their own tests, and then they provide us with the results. Now, some of them will show phenomenal achievement, and some will struggle. But the nature of the experience is still moving in the right direction.

All I want is for the institution to open up the doors of knowledge to these individuals. So you've got to bring it to the cell.

On any given day, your jails hold nearly 20,000 people. You have a range of vocational, high-school equivalency and life-skills courses already in place, but at this point, only about 32 percent of your inmates get any kind of education.

Which is pretty high for a local jail. It takes awhile to get all the equipment, all the procedures in place, to get the inmates acclimated to daily study. We'll start doing some study as to how effective this is and whether we're reaching too high. But the truth is if you don't set a high goal, you'll never get a little one accomplished.

In the jails you've got an incredibly transitory population, people coming in and out all the time. Isn't that a problem?

It's an issue. But 80 percent go on to state prison. They don't get convicted until about an average stay of a year in the county jail. So I've got a starting point with them.

The average prison sentence is about eight or nine years. You can do a lot with that eight or nine years if you're in a learning track and you have unlimited educational resources. You can come out of there a totally different person.

But if you start someone on a program to get their GED or learn to read, and then they move on to state prison …

The state prisons have to pick it up from there. I'm on the board of the California Department of Corrections and Rehabilitation. I know they're strapped with budget woes, but so am I. It's up to us to do this without asking the taxpayers for billions of dollars with which to do it. I'm trying to show this can be done in a way that's cost effective without building classrooms and adding teachers and all these other things. We have to stimulate their interest in broader subjects than the ones they brought with them to jail.

The idea of getting people to stop being criminals by educating them was very popular back in the '60s and '70s but has fallen out of fashion. Why?

Well, they were using the word "rehabilitation" as though you can tell a person, "I can change you." I'm not telling them that I can change them. I'm saying, "What you know will change you." It's not pounding license plates; it's not doing laundry work. Those are the traditional rehabilitation programs — put them to work, keep them busy, teach them some skills. Truth is, those are time-passing forms of work that keep the prison institution in order. I have all that. But I don't want my inmate cooks or printers thinking they're going to go out and become a cook or a printer. Some will do that, but it's such a small number.

The jails only have so many vocational opportunities, and there's not enough to satisfy the current demand. So I am not talking about rehabilitation. I am talking about education. They'll have to choose their survival mode when they get out. But if they have a stronger base of thought and wisdom and knowledge, they can choose their next step in life more effectively.

So it's more about changing their mindset than teaching them specific knowledge?

Right. I got my doctorate at USC in public administration, and I studied learning theory. You're not going learn anything if the tools of knowledge aren't in front of you. This is the big problem in the state and federal prison systems and the local county jails — we see prisoners from the perspective of anger because they victimize people. I understand that. I'm angry, too, that they commit these thoughtless crimes. But at the same time, you step back from being a victim and say, "All right, my car was stolen, my house was broken into, I want this person put in jail." Agreed. But when they get out, what do you want this person to be? Do you want this person to continue to victimize other people, or to stop it altogether?

The education initiative is being paid for from the Inmate Welfare Fund (fees paid to the county from businesses operating vending machines, pay phones and other services in jails). Is there enough money?

The point is we're working within our means. Yeah, there's enough to reach every inmate.

If you need stimulus money to do any damn thing creative, you'll never get anything done. I'm creating these mechanisms that are extraordinarily cost reductive. I'm not building out some monolithic educational institution based on some theoretical precedent on school construction theory. I'm saying the institution has to re-create itself from within. I'm building a system from within my confines. And it's all about giving prisoners educational tracks, learning domains that are helpful to the enrichment of their brain.

You've got to keep that mind working. Redemption doesn't occur when you get out of prison. Redemption occurs when you decide you no longer want to commit bad deeds. Then you're redeemed.

http://www.miller-mccune.com/legal-affairs/lee-baca-wants-to-educate-l-a-s-prisoners-29876/

Why Whites Avoid Movies With Black Actors

New research suggests white audiences tend to stay away from movies featuring minorities due to the assumption that the film "wasn't made for me."

By Tom Jacobs

A scene from "Fast Five" starring Paul Walker, left, and Vin Diesel — a movie with a multiracial cast that's doing enormously well at the box office. Researchers suggest white audiences tend to stay away from movies with all-black casts because they don't feel they were the intended audience. (Courtesy Universal)

In terms of box-office grosses, this is an extraordinary week for Hollywood: The No. 1 movie in America features a mixed-race cast.

Granted, that movie is *Fast Five*, the fifth installment of the *Fast and Furious* action series. *Boston Globe* film critic Wesley Morris called these films "loud, ludicrous and visually incoherent," but added that they are "the most progressive force in Hollywood today."

As Morris noted, nonwhite actors played major roles in only two of the 30 top-grossing films of 2010. Studio executives believe white audiences prefer to see white characters, while black audiences want to see black characters, so they increasingly make films for each demographic.

Are they being too cynical? Newly published research suggests the answer is, sadly, no. But it also suggests this troubling tendency may largely be the effect of the studios' all-too-effective marketing strategies.

In short, white moviegoers seem convinced that films with black stars are not made for them.

Andrew Weaver of the Indiana University Department of Telecommunications explored how the racial makeup of the cast impacts the preferences of white filmgoers. Writing in the *Journal of Communication,* he described an experiment in which 68 white college undergraduates read 12 fictional synopses of new romantic comedies.

"Web pages were created for each movie, and the race of the characters was manipulated to create six versions: an all-white cast; a 70 percent white cast with two white leads; a 70 percent white cast with a white and a black lead; a 70 percent black cast with a white and a black lead; a 70 percent black cast with two black leads; and an all-black cast," he noted.

After looking over the pages, which featured small photos of the principal cast members, participants were asked a series of questions about their moviegoing habits, racial attitudes and desire to see each movie, either in a theater or at home.

"The higher the percentage of black actors in the movie, the less interested white participants were in seeing the movie," Weaver reports. "Importantly, this effect occurred regardless of participants' racial attitudes or actors' relative celebrity."

A separate study that used the same technique to assess non-romantic films produced different results. For the participants, 79 white undergraduates, the race of the actors did not influence their desire to see the film.

But a follow-up study by Weaver, which has yet to be published, suggests that result may be an outlier. In it, he used the same technique, but his participants were drawn from a more diverse group in terms of age and education. Specifically, he analyzed the responses of 150 white people between the ages of 18 and 69.

"White participants were more interested in seeing films with white actors than films with black actors," he found. "This main effect was quite robust, occurring regardless of gender, age, previous movie viewing or the genre of the movie.

"Moreover, this effect was significant despite the very subtle race manipulation. The movie synopses, which were front and center on the page, were unaltered. The only manipulation was in the thumbnail pictures attached to the actors' names."

Evidence of continuing racist attitudes on the part of white Americans? Not necessarily. Participants were asked whether they perceived they were similar to the characters, and whether they considered the movie's plot relevant to their own lives. Weaver found the race of the actors did not significantly affect their replies.

However, the actors' race did have a big impact on another issue: Whether the participants felt they were part of the "intended audience" for the film. Their likelihood to agree decreased significantly when 70 percent (or 100 percent) of the cast was black, and they were less likely to express interest in seeing those films.

This suggests to Weaver that white reluctance to see films with black actors can be overcome. The perception that "this movie is not for me" could be changed "if more mainstream movies cast minorities," he writes. If multiracial casts became the norm and movies were marketed to all demographics, the stigma could fade away.

This won't happen anytime soon: Hollywood is famously risk-averse. Then again, the enormous success of *Fast Five,* which made more than $83 million domestically in its first weekend of release, may inspire other producers to take a risk on multiracial casts — perhaps even for films in which the real stars aren't the cars.

http://www.miller-mccune.com/culture-society/why-whites-avoid-movies-with-black-actors-30890/

Gas drilling contaminates drinking water

- 17:16 10 May 2011 by **Sujata Gupta**

Drilling for shale gas may pose a safety hazard if there are water wells nearby. But the controversial use of "fracking" does not appear to be a safety risk as regards water contamination.

Over the past decade, the use of fracking – a mining technique involving pumping water and chemicals underground to rupture rocks and bring trapped natural gas to the surface – has skyrocketed in Pennsylvania. The state sits atop the Marcellus shale, a deposit estimated to harbour over 14 trillion cubic metres of natural gas. Residents have long expressed concerns that fracking could contaminate drinking water.

Now a study has shown that the real safety concern is the proximity of water wells to gas wells, and that fracking does not appear to increase the risk of water contamination.

Rob Jackson of Duke University in Durham, North Carolina, and colleagues analysed water from 68 drinking wells in upstate New York, where fracking is banned, and Pennsylvania. They found that wells located within 1 kilometre of an active shale-gas drilling site contained 17 times as much methane on average as those further away.

The team was also able to confirm that the methane found in the drinking water came from deep within the Earth and was not produced at the surface by bacteria. The implication is that the contaminating gas came from the drilling sites.

Explosion hazard

While little is known about how this methane might affect health, its presence at elevated levels is an explosion hazard, says Jackson. Across the US, explosions in water wells have been linked to the presence of the gas in water. A 2008 report by the Ohio Department of Natural Resources found gas drilling to be at fault in one such explosion beneath a home.

Jackson says the methane is probably seeping out from cracks in gas well casings, so improving the way these are sealed should solve the problem.

Bryan Swistock, a water resources expert at Pennsylvania State University in University Park, says that the state has already introduced new standards for casing and sealing gas wells. "It would be interesting to continue this study [now the new standards are in place]," he says.

Journal reference: *Proceedings of the National Academy of Sciences*, DOI: 10.1073/pnas.1100682108

http://www.newscientist.com/article/dn20463-gas-drilling-contaminates-drinking-water.html?full=true&print=true

Blue alert: The dark side of night light

- 10 May 2011 by **David C. Holzman**
- Magazine issue 2811.

Light from televisions and phones could be disrupting our clocks (Image: Ryan McVay/Getty)

From streetlights to smartphones, our world is bathed in artificial light – but we're only just waking up to the havoc that wreaks on our health

"THESE people aren't really blind, they are lying." So stated one journal editor when confronted by an experiment whose results seemed impossible.

The experiment involved clocks. Body clocks. Our internal clocks tend to run a little fast or slow, so if we are deprived of any clues to what time it is, we soon get out of sync with the day-night cycle. It used to be thought that our everyday activities kept our clocks on time, but a series of studies in the 1980s revealed that light is the key. The clincher came in 1986, when Charles Czeisler showed that light could be used to reset people's clocks in the same way that one might reset a watch.

The findings helped explain why many blind people suffer periodic sleep disturbances. Because they cannot detect light, their body clocks go in and out of sync with the day-night cycle. But Czeisler, of Harvard Medical School, knew that the clocks of a few blind individuals ran on time. How was this possible?

Czeisler showed that their clocks were also set by light - and that their eyes were somehow detecting it even though these individuals had no conscious awareness of light. That suggested that our eyes have special light receptors that are quite separate from those we see with, and that must have been overlooked despite centuries of research. "That just blew us away," he says.

After 20 rejections over five years and numerous additional tests to rule out other explanations, Czeisler's paper was published in 1995. Other researchers soon identified the mechanism behind what he had found. We now know there are specialised light-detecting cells in the retina whose signals go to the master clock in the brain, rather than to the visual cortex. In some blind people this system remains unaffected by whatever caused their blindness, allowing their clocks to stay on time.

These discoveries are turning out to have profound implications. It is becoming clear that even dim lights can affect our body clocks, meaning simply having the lights on late at night or staring at a computer screen can disrupt our internal rhythms. What's more, it turns out that blue light has the greatest power to change our clocks, and modern lighting is getting bluer. The potential effects go far beyond the unpleasant, jet-lagged feeling that body-clock disruption can cause. There is growing evidence that continual disruption is linked in the long term to serious illnesses including cancer, heart disease and diabetes. It can even alter the wiring of our brains.

It is not all bad news. Bright light during the day has, of course, long been known to mitigate the depressive effect of long dark winters on people who suffer from seasonal affective disorder, and recent research has demonstrated more general benefits. For example, elderly nursing-home residents exposed to very bright indoor light (around 1000 lux - roughly equivalent to outdoor light on an overcast day) for an hour in the

morning were less likely to show signs of depression, according to a 2008 study (*Journal of the American Medical Association*, vol 299, p 2642).

Part of the reason for this is that our central clocks control levels of the hormone melatonin. When it gets dark, our melatonin levels rise, making us sleepy, while bright light turns off melatonin production and makes us more alert.

So light at night actually has two distinct effects. It can reset our internal clocks, as Czeisler showed, and it can also suppress the production of melatonin. The first to suspect the suppression of melatonin could affect our health was Richard Stevens at the University of Connecticut Health Center in Farmington. During the 1980s, he was investigating the causes of breast cancer, rates of which are much higher in developed countries. Stevens came across studies that suggested that too much light could alter the development of breast tissue and suppress melatonin secretion, and that lower melatonin might boost oestrogen levels.

That all came together for him one night as a street light shone into his apartment. He realised that the introduction of bright artificial lighting was a profound change in our environment, one that could be affecting our health in many ways. The idea became known as the light-at-night hypothesis, and there is growing evidence in support of it.

Several epidemiological studies suggest there is indeed a link between light-at-night and cancer, particularly breast cancer. Perhaps the most direct evidence comes from a study by David Blask of Tulane University School of Medicine, New Orleans, and collaborators. They implanted human breast tumours into female rats and pumped the tumours with blood from healthy women. The blood had been collected either in daylight, or at night after the women experienced 2 hours of complete darkness, or at night following 90 minutes under bright fluorescent light.

The melatonin-rich blood taken from subjects in total darkness severely slowed the tumours' growth, they found. Conversely, tumours grew much faster after receiving melatonin-depleted blood from women exposed to light (*Cancer Research*, vol 65, p 22274). "We can manipulate light and melatonin levels, and thus cancer growth rates, almost like a dimmer switch," says Blask.

Tumours also grow faster in mice made to follow schedules mimicking shift work or jet lag, says Steven Lockley of Harvard Medical School in Boston. The evidence implicating shift work in breast cancer is so extensive that in 2007 the World Health Organization categorised shift work as a probable cause of cancer.

If melatonin is the key, it is plausible that anything that suppresses melatonin could increase the risk of cancer. Lockley points out that totally blind women - with no functioning light receptors at all in their eyes - have a breast cancer risk half that of their sighted counterparts. "The totally blind women never have their melatonin perturbed, which may be the reason why their cancer risk is less," he says.

Besides cancer, disruption of our body clock and melatonin suppression have been linked to obesity, diabetes and cardiovascular disease. Studies show that night-shift workers have higher rates of heart attack and stroke than those on day schedules, for instance, and that the difference grows with the number of years spent doing the job.

Impaired thinking

Animal studies show that disrupted routines can even alter the wiring of the brain, impairing cognitive function, it was reported earlier this year (*Proceedings of the National Academy of Sciences*, vol 108, p 1657). Ilia Karatsoreos of The Rockefeller University in New York found that mice kept on an unnatural cycle of 10 hours of light followed by 10 hours of darkness lost neuronal complexity in the prelimbic prefrontal cortex, an executive part of the brain. Karatsoreos thinks the results are relevant to people. "I think this study is proof in principle that disrupting the clock by changing the light cycle can result in changes in the brain, behaviour and physiology," he says.

However, imposing a 20-hour cycle is like "hitting the system over the head with a hammer", he cautions. It remains to be seen if milder disruptions also have these effects.

Meanwhile, studies have been showing that the blue wavelengths are by far the most powerful in shifting rhythms and suppressing melatonin. In 2001, George Brainard of Thomas Jefferson University in Philadelphia, Pennsylvania, and collaborators found that melatonin secretion was most powerfully suppressed when volunteers were exposed to very bright light at around 2 am, at wavelengths from 450 to 480 nanometres - squarely in the blue part of the spectrum (*Journal of Neuroscience*, vol 21, p 6405).

The findings suggested that the special receptor cells in our retinas contain a light-sensitive protein distinct from those we see with, and that it responds mainly to blue light. Sure enough, the cells were shown to contain a protein called melanopsin the following year.

In similar experiments involving extended nocturnal exposure to light, Brainard, Czeisler and Lockley showed that pure blue light of 460 nm suppressed melatonin for roughly twice as long as green light of 555 nm (*Journal of Clinical Endocrinology & Metabolism*, vol 88, p 4502). The blue light also reset people's internal clocks by 3 hours on average, compared with just an hour and a half for green light. Resetting clocks in this way means people find it hard to get to sleep the following night, and then feel tired in the morning.

More evidence comes from a study led by Leonid Kayumov at the University of Toronto, Canada. He asked some volunteers to wear goggles designed to filter out blue light. When volunteers did simulated shift work under bright indoor light (800 lux), melatonin production was suppressed in those not using the goggles, whereas those wearing goggles had melatonin secretion profiles similar to those of subjects exposed to dim light (*Journal of Clinical Endocrinology & Metabolism*, vol 90, p 2755). This suggests the use of such goggles could minimise the impact on shift workers or people staying up late (see "Use light right").

While blue light is worst in terms of affecting our body clocks at night, it is also the best kind of light to have by day. Dieter Kunz of the Clinical Chronobiology Research Group at Charité University of Medicine in Berlin, Germany, waxes lyrical about the benefits of blue. "Bright blue in the morning is incredible. Throw away the pills," he jokes. Blue light also has the greatest power to keep us alert. Lockley has shown that people exposed to pure blue light responded faster in tests and made fewer mistakes than those exposed to pure green light (*Sleep*, vol 29, p 161).

So blue wavelengths appear to have the greatest influence on human physiology, day or night. There have been claims that full-spectrum lighting, which contains a mixture of all visible wavelengths and resembles natural daylight, is best for working environments, but the level of blue matters most as far as alertness is concerned.

These findings suggest that if light at night is a serious issue, it could be getting worse. Low-energy fluorescent bulbs and LED-based lighting usually produce much more blue light than the old-fashioned tungsten light bulbs they are replacing (see "True colours").

What's more, while most studies into the effects of night-time light have involved intense illumination over extended periods, recent studies are showing that normal home lighting and even dim light may be disruptive to human physiology. A study published earlier this year, for instance, found that for people exposed to normal room lighting in the late evening - less than 200 lux - melatonin levels rose later than in people subjected to dim lighting, and then remained high for about 90 minutes less (*Journal of Clinical Endocrinology & Metabolism*, vol 96, p 463). "One hundred lux gives 50 per cent of the maximal response under very bright light, and melatonin suppression can be measured at much lower light levels," says Lockley.

Besides suppressing melatonin, even relatively dim light sources such as table lamps and computer monitors can set back our internal clocks. "Our lab has shown that less than 8 lux is capable of entraining the circadian clock," says Lockely. The team speculates that this might explain the high prevalence of delayed sleep phase disorder, in which people have trouble getting to sleep and then wake up feeling tired. So how serious is this problem? "We have no idea what chronic low-light exposure does as the entire world is self-experimenting on using electric light at night," he says.

The degree of harm is likely to depend on the degree of disruption, Lockley says, but it would take a very large study to prove this. However, there is already plenty of evidence linking short sleep duration to increased risks of cardiovascular disease, stroke, high blood presssure, diabetes and depression.

It is a problem people can do something about. While researchers remain reluctant to provide specific guidelines for night-time lighting, we can get a glimpse of the latest thinking in this area from NASA. It recently reduced the upper limit of illumination in the general sleeping areas of spacecraft, where some astronauts might be active as their colleagues doze, from 20 lux to 1 lux (a lux is roughly equivalent to full moonlight). For dedicated sleeping areas, the upper limit is 0.02 lux (equivalent to a quarter moon).

Manufacturers could also help by selling lights for use at night that produce less blue. In fact, one newly launched kind of low-energy lighting, called ESL, has a spectrum more like that of incandescent bulbs.

Changing light bulbs is relatively easy. The hard part will be persuading people to turn off their TVs and put down their iPads well before they go to sleep.

Use light right

Be Alert in the day, sleep well at night
• Get lots of bright light during the day, especially in the morning. It will make you more alert and happier, and help you sleep at night.
• As you get older, you will need more light during the day. The lens of the eye lets less light through as you age: in particular, it lets through less blue light, which is most important for setting your clock.
• Dim the lights well before your bedtime. That means no bright screens, either - including televisions, computers and smartphones.
• Maintain a consistent bedtime and wake time from day to day.
• Time spent in the dark makes your body clock more sensitive to light. If you have to get up during the night, use a dim red light to minimise any disruption.
• Avoid caffeine late in the day and develop a relaxing bedtime routine.
• If, despite doing all the above, you still struggle to sleep, try wearing amber-coloured goggles in the hours before bed. They are commercially available and designed to filter out blue wavelengths.
David C. Holzman *is a freelance science writer based in Lexington, Massachusetts*

http://www.newscientist.com/article/mg21028111.400-blue-alert-the-dark-side-of-night-light.html?full=true&print=true

Drug pacemaker relieves hassle of daily shots

- 05 May 2011 by **Jessica Hamzelou**
- Magazine issue 2811.

No more needles? (Image: Adam Gault/Getty)

DAILY injections can be a pain in the backside, literally. A new drug-release implant that could deliver timed doses for a year may provide some relief.

So say Bob Farra and colleagues at Microchips in Waltham, Massachusetts, who are developing the pacemaker-like device.

Inserted under the skin, it features a chip with a number of metal-walled wells containing a drug. To seal the wells without using heat, which could affect the potency of the drug inside, the group uses a process called interference fitting. "It's like forcing together pieces of a jigsaw puzzle that don't quite fit," says Farra. The process crushes the lid to the sides of the well, forming a tight seal.

Each well is wired to a battery. When an electric current is applied to a well, part of the container melts, releasing the drug. The current can be controlled from outside the body or can be pre-programmed (*Nature Biotechnology*, DOI: 10.1038/nbt1199).

The team are now testing a 20-well version of the device in people with osteoporosis. The only bone-building therapy on offer for these individuals is a daily injection of parathyroid hormone, and many are unwilling to commit to this, says Farra.

The team denies that a fault in the device could cause a drug overdose. The battery does not generate enough power to open all the wells at once, says Farra. What's more, the metal cover for each well is robust: only a pressure equivalent to the weight of an average-sized car directly on the chip would damage it.

Microchips has licensed the technology to a company that plans to insert a smaller version of the device into the eyes of people with macular degeneration. At present these people risk going blind unless they have frequent injections into their eyes, says Ajit Gill, also at the company.

Vincent Lee at the Chinese University of Hong Kong points out that only drugs potent enough to work in small volumes could be used in the device, and that they would have to remain stable for months in the body. "Were these hurdles overcome, this invention would accelerate the implementation of personalised drug therapy," he says.

http://www.newscientist.com/article/mg21028114.100-drug-pacemaker-relieves-hassle-of-daily-shots.html

First evidence that gorillas pass on traditions

- 13:41 10 May 2011 by **Matt Kaplan**

Another prickly bite (Image: Denise Hardy/Port Lympne)

Chimps and orang-utans are well known for their ability to develop tool-using tricks and transmit these within their social groups. But because gorillas are comparatively poorly studied, it's unclear whether they develop such "traditions". A study now suggests they do.

Richard Byrne at the University of St Andrews, UK, and colleagues looked at how captive-bred gorillas picked apart stinging nettles to eat them. They noticed that the apes never detached the stinging leaf stalks and reduced their exposure to stings by squeezing nettles together.

"This fascinated us because, while wild gorillas in Rwanda also pick apart stinging nettles, they do so by removing stalks and folding, rather than squeezing, the nettles," says Byrne.

You can see the difference in the video above. In the first clip a captive lowland gorilla in Port Lympne, Kent, strips nettle leaves off their stem, but doesn't twist off the stalk. Then he rolls and scrunches the bundle. The ape tucks in the leaf tips to tidy up his bundle before eating it.

In the second clip a wild mountain gorilla from Karisoke, Rwanda, strips the leaves from the stem, twists off the sting-infested stalks that attach the leaves to the stem, and then carefully folds the bundle over her thumb, underside up so that the stinging topsides are tucked away – rather than scrunching it – and pops the tidy package into her mouth.

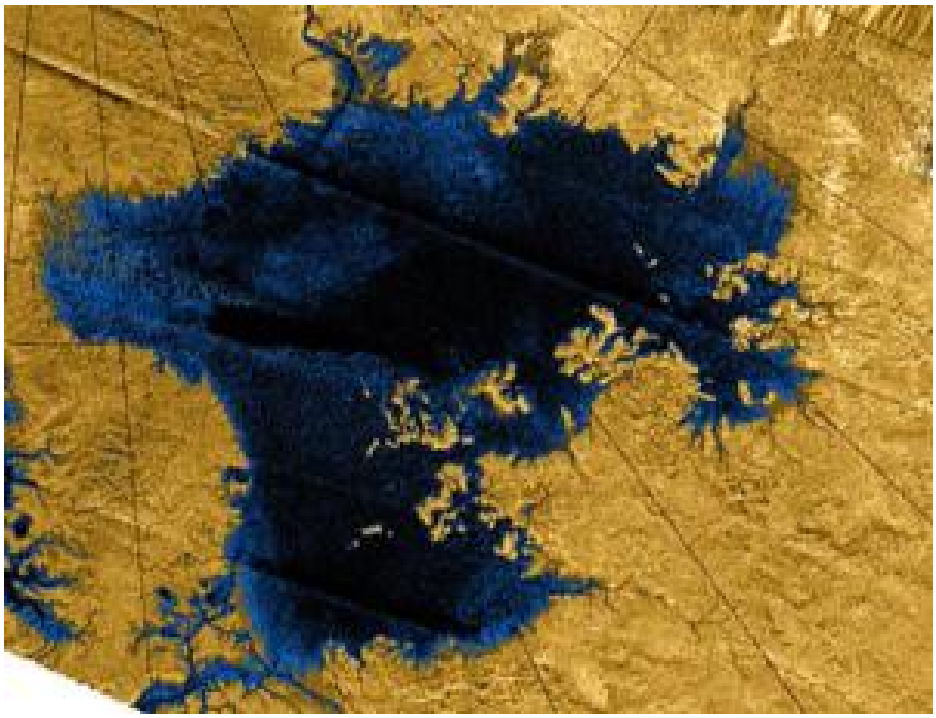
Byrne argues that each group developed its own tactics and spread them among themselves. "The perfect study would compare only wild gorillas or only captive ones, but when that is not possible, studies like these are valuable," says primatologist Elizabeth Lonsdorf at the Lincoln Park Zoo in Chicago. "I think we've only scratched the surface of gorilla learning abilities."

Journal reference: *Animal Cognition*, DOI: 10.1007/s10071-011-0403-8

http://www.newscientist.com/article/dn20460-first-evidence-that-gorillas-pass-on-traditions.html

NASA floats Titan boat concept

- 21:56 09 May 2011 by **David Shiga**



The TiME mission would send a flying-saucer-shaped probe to float in Ligeia Mare, a 400-kilometre-long hydrocarbon lake on Titan (Image: NASA/JPL/USGS)

No one has ever floated a boat on another world, but NASA is now considering doing just that, on Saturn's icy moon Titan. Probing the moon's hydrocarbon lakes could reveal clues to its climate and perhaps even signs of exotic life forms.

Titan's surface is dotted with lakes, making it strangely reminiscent of Earth. But rather than water, the lakes are filled with a mixture of methane and ethane, which are gases on Earth but are liquid at Titan's surface temperature of -180 °C.

NASA is now considering sending a probe to splash down into one of the lakes. It has selected a mission called the Titan Mare Explorer (TiME) as one of three finalists competing for a chance to fly in 2016. The TiME project is led by Ellen Stofan of Proxemy Research in Gaithersburg, Maryland.

In 2023, after a seven-year cruise from Earth, TiME would parachute into a lake in Titan's northern hemisphere called Ligeia Mare. Powered by heat from the decay of an onboard plutonium supply, the probe would bob around the lake's surface and make measurements for about three months.

Titan is the only place in the solar system that appears to have a cycle analogous to the water cycle on Earth, with hydrocarbon rain depositing liquid on the surface, followed by evaporation and more rain.

Rain-lashed probe?

TiME would help reveal details about this cycle by measuring the temperature, humidity and winds at the surface of the lake. With luck, it could be the first probe to experience rain on another world. The probe would also snap pictures of the lake's surface and shorelines and peer up at clouds in the sky.

Though it lacks a means of propulsion, the flying-saucer shaped probe should gradually drift with the breeze, allowing it to sample different parts of the lake. As it did so, it could measure the lake's depth with sonar and taste the brew of chemicals it contains with a mass spectrometer.

That would provide a new window into Titan's intriguing chemistry. Complex carbon-based, or organic, molecules, such as acetylene, are known to form in abundance in the moon's atmosphere and rain down onto the surface.
The organic molecules are likely to get mixed into the lakes and might undergo further chemical reactions there. Some scientists have even speculated that microscopic life forms could live in the lakes, eating acetylene and breathing hydrogen gas.

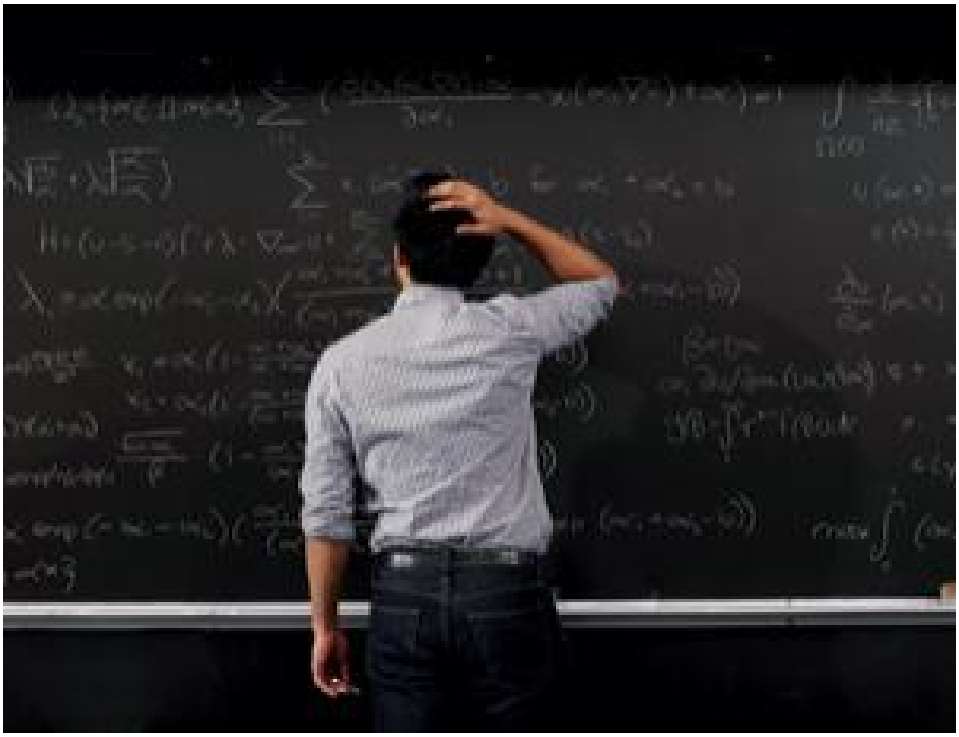
Searching for signs of life

With its mass spectrometer, TiME would explore any interesting chemistry going on in the lake. If any life is present, it might produce unusual patterns in the abundance of organic molecules.
"Titan is an endpoint on exploring what are the limits to life in our solar system," Stofan told *New Scientist*. "We're going to be looking for patterns in abundances of compounds to look for evidence for more complex or interesting reactions."
But in order to fly, TiME will have to out-compete two other proposed missions: a seismic monitoring station for Mars and a probe that would hop around the surface of a comet.
NASA has awarded $3 million to each of the three competing teams to flesh out their mission concepts. After a review in 2012, the agency plans to decide which mission will receive the $425 million it needs to fly.

http://www.newscientist.com/article/dn20459-nasa-floats-titan-boat-concept.html?full=true&print=true

How to build the global mathematics brain

- Updated 11:26 06 May 2011 by **Jacob Aron**
- Magazine issue 2811.



The end of the solitary genius (Image: Dirk Anschütz/Corbis)

MATHEMATICIANS don't have to be brilliant loners. The first analysis of a successful wiki-style mathematical project shows how a large-scale collaboration made up of amateurs and professionals can be just as effective.

The project, called Polymath, was born in January 2009 when University of Cambridge mathematician Timothy Gowers proposed it in a blog post. Another leading mathematician, Terence Tao of the University of California, Los Angeles, flagged the idea on his own blog. The project began in earnest with a wiki for collecting the mathematical contributions made to these and other blogs.

Polymath does more than just bring together pre-existing knowledge, Wikipedia-style. It is an attempt to divvy up and democratise the process of mathematical discovery. Gowers likens it to wiring together multiple mathematical brains to form a "super-brain". "I'm interested in the question of whether it is possible for lots of people to solve one single problem rather than lots of people to solve one problem each," he wrote on his blog.

Now computer scientists Justin Cranshaw and Aniket Kittur at Carnegie Mellon University in Pittsburgh, Pennsylvania, have analysed whether his vision has been borne out. As well as identifying the factors that made Polymath a success, they offer a set of design principles for future collective efforts, and highlight strategies for harnessing the talents of mathematically minded individuals who would not otherwise be at the cutting edge of discovery (see "Amateur mathematician: a teacher's tale").

The pair focused on the first problem tackled by Polymath. Dubbed Polymath1, it was an attempt to find an alternative proof to the density Hales-Jewett (DHJ) theorem. This lies in an area called combinatorics that involves counting and rearranging mathematical objects.

Imagine colouring in squares in a grid. What percentage can you colour before you are forced to make a straight line along a row, column or diagonal? The DHJ theorem says the percentage decreases in cubic grids,

and in higher-dimensional grids the percentages goes to zero as almost any square you colour will result in a line.
Although a proof existed, it was difficult and written in the language of a branch of mathematics called ergodic theory. The challenge was to find a simpler proof based on combinatorics.
Six weeks in, and the 39 contributors to Polymath1 had done it. That's a blistering pace for something so complex. The proof has been submitted for publication under the pseudonym D.H.J.Polymath. "The success of Polymath1 is a proof of concept that you can do math this way," says Cranshaw.
To reveal how this was achieved, he and Kittur examined the process in detail. It began with Gowers posting an outline of the DHJ problem to his blog, along with some ground rules for working together. Tao and Gowers followed up with posts devoted to different, specific aspects of the proof, to which anyone could post a comment. These comments might consist of a few equations, a suggestion for how to proceed next or proof-checking. After 100 comments, Gowers or Tao would summarise the thread, ensuring loose ideas were turned into mathematical statements. Ideas were also summarised on the wiki, which served as the central location for the effort.
Cranshaw and Kittur mapped out the network of 1228 comments, examining the relationships between them and ranking them in order of importance to the final proof. Commenters ranged from amateur mathematicians to university professors, but the significance of their contributions did not depend on their academic seniority. While Tao and Gowers were the most prolific commenters, and among the most highly rated, people who made just a few comments also had a large impact on the final proof (see graph). This suggests individuals can help solve a problem without committing a huge amount of time or effort, which was part of Gowers's vision for the project.
Gowers was struck by another benefit provided by the collaboration. "Reading the discussion provides some kind of strange random stimulus that causes your brain to go in to fruitful places where it might not have done otherwise," he says. "It's a strange effect, but it was a very powerful one."
The analysis also identifies the essential role played by Gowers and Tao's leadership. Both have won the Fields medal, mathematics's equivalent of the Nobel prize, and Cranshaw suggests that their status helped to draw in collaborators. "You have grad students who get a chance to work with Terry Tao and Tim Gowers - that just wouldn't happen normally without this project."
But Tao dismisses any idea that you need a leading mathematician to moderate the discussion. All it takes is someone "willing to invest a fair amount of time and energy into organising the discussion and keeping it coherent".
Cranshaw and Kittur will present their results next week at the Conference on Human Factors in Computing Systems in Vancouver, Canada.
Cranshaw says there is a "huge" scope to enhance Polymath. He believes the existing structure of consecutive posts is unhelpful, especially for participants who come in late and have to wade through posts in chronological order before contributing.
"In math the relationship between ideas is really important, but I'm not sure that comes across," Cranshaw says. He also suggests ranking comments by importance as he and Kittur did in their study, or allowing users to vote on comments.
Gowers would like contributions to be arranged on a kind of giant virtual blackboard that would show how different strands of the discussion link together. Translating this vision to a computer screen would be a "major challenge", he admits.
So is the collaborative Polymath the future of a once-solitary subject? "I view it still as a small-scale experiment," says Tao. "But I think massively collaborative projects in mathematics will become more common in the future, even if they don't necessarily follow a Polymath-type format."
When this article was first posted, we misstated the exact details of the DHJ theorem.

Amateur mathematicians: a teacher's tale

Contributing to Polymath, a collaborative approach to solving mathematical problems, requires some mathematical knowledge, but you don't have to be a professional. "I originally didn't think that anything unsolved was at all approachable," says Jason Dyer, a mathematics teacher in Arizona who participated in Polymath1, and other problems. "Doing this has helped increase my own mathematical confidence."
Dyer admits he wasn't able to follow all the high-level mathematical arguments, but found he could still make a worthwhile contribution by thinking about a simple kind of logic puzzle known as Fujimura's problem. This

involves coins arranged in triangular grids, and asks how many coins can be removed before the triangular structure is lost. "It's not a hard problem," say Dyer. "It's just nobody had explored it at a real mathematical level."
As it turns out, Fujimara's problem did not relate to the Polymath1 problem in the way Dyer and others had suspected. But by exploring the puzzle, Dyer was able to contribute significantly to the final proof.
Could Polymath uncover "raw" geniuses outside the traditional community of mathematicians, rather like legendary self-taught mathematician Srinivasa Ramanujan? "The nature of mathematics has changed since Ramanujan's day," says Terence Tao, a co-founder of Polymath. "In the more mature areas, knowledge of existing mathematics is significantly more important than raw ability." But, as Dyer shows, non-traditional mathematicians can still contribute.

http://www.newscientist.com/article/mg21028113.900-how-to-build-the-global-mathematics-brain.html

The limits of knowledge: Things we'll never understand

- 09 May 2011 by **Michael Brooks**
- Magazine issue 2811.

What we'll never know (Image: Andy Potts

From the machinery of life to the fate of the cosmos, what can't science explain?

YOU might not expect the UK's Astronomer Royal to make too many pronouncements about what chimpanzees think, but that is one of Martin Rees's favourite topics. He reckons we can learn a lesson from what they understand about the world - or, rather, what they don't. "A chimpanzee can't understand quantum mechanics," Rees points out.

That might sound like a statement of the obvious. After all, as Richard Feynman famously said, nobody understands quantum mechanics. The point, though, is that chimps don't even know what they don't understand. "It's not that a chimpanzee is struggling to understand quantum mechanics," Rees says. "It's not even aware of it." The question that intrigues Rees is whether there are facets of the universe to which we humans are similarly oblivious. "There is no reason to believe that our brains are matched to understanding every level of reality," he says.

We live in an age in which science enjoys remarkable success. We have mapped out a grand scheme of how the physical universe works on scales from quarks to galactic clusters, and of the living world from the molecular machinery of cells to the biosphere. There are gaps, of course, but many of them are narrowing. The scientific endeavour has proved remarkably fruitful, especially when you consider that our brains evolved for survival on the African savannah, not to ponder life, the universe and everything. So, having come this far, is there any stopping us?

The answer has to be yes: there are limits to science. There are some things we can never know for sure because of the fundamental constraints of the physical world. Then there are the problems that we will probably never solve because of the way our brains work. And there may be equivalents to Rees's observation about chimps and quantum mechanics - concepts that will forever lie beyond our ken.

But the limits in knowledge and understanding that we do recognise are, if anything, cause for celebration. They represent some of the most fertile ground for us to explore; ever creative, scientists are learning how to turn obstacles into opportunities. We may never be able to know everything, but discovering what we cannot know usually leads to us knowing more.

Perhaps the most fundamental limitation on knowledge is the cosmic horizon beyond which we will never see. This derives from one of nature's unbreakable rules: nothing can travel faster than light. In 1929, Edwin Hubble discovered that the universe is expanding. Everything is moving away from us, and the expansion is fastest at the most distant reaches of the universe. Any object that is more than 46 billion light years (4×10^{23} kilometres) away is receding at more than the speed of light. (Though nothing can travel through space faster than light, the fabric of the universe itself can expand faster.)

From the moment that an object slips over the horizon, no light it emits will ever arrive at Earth - and the same goes for any other information about it. All we have is the data that has had time to reach us during the lifetime of the universe. The rest - possibly an infinite amount - is lost to us forever.

What is beyond the cosmic horizon? We don't know, but it is generally assumed that the unobservable part of the universe is much the same as the part we can see. However, that assumption has recently been challenged by the discovery of more than 1000 distant galaxy clusters rushing towards the same point in the sky (*New Scientist*, 23 January 2009, p 50). This "dark flow" hints that there might be megastructures beyond the horizon that are unlike anything we have observed.

Today's unknowns

The limitation imposed by the speed of light means we may never know whether they exist or not. But that dark cloud comes with a silver lining. The discovery of a finite speed of light paved the way for Einstein to twig that everything else in the universe is bound by the speed limit - an idea that revolutionised physics in the form of special relativity.

Another fundamental constraint on our knowledge is the feature of quantum mechanics we know as the Heisenberg uncertainty principle. This has its roots in the discovery that certain things in nature, such as energy, are packaged up in fundamental, indivisible units called quanta. In the 1920s, Werner Heisenberg realised that the measurable characteristics of a quantum object such as an electron do not have a defined value, but many possible values each with a probability attached to it. To pin the value down means taking lots of separate measurements, but doing so blurs our knowledge of another characteristic. The best-known consequence is that we can never simultaneously know a particle's exact position and momentum.

Although Heisenberg unearthed this principle by digging into the mathematics of quantum theory, it has a physical explanation. Bounce a photon off a particle in order to establish its position, and the impact will change the particle's momentum. Thus accurate measurement of both position and momentum simultaneously is impossible.

This places a theoretical limit on our knowledge, but the discovery of the uncertainty principle led to numerous breakthroughs elsewhere. "At first glance, it might seem that uncertainty is 'bad', in the sense that it limits how much we can hope to learn," says Stephanie Wehner of the Centre for Quantum Technologies at the National University of Singapore. "However, the principle isn't really a road block, it's more like a stepping stone. It provides a tool for exploring the quantum world."

Importantly for you and me, we wouldn't be here without it: the uncertainty principle provides our best explanation for how the entire universe came into being. That's because uncertainty shatters the notion that anything ever has exactly zero energy. So the universe could have come into existence spontaneously when its energy state momentarily flickered away from zero. Heisenberg himself pointed out that uncertainty in time measurements destroys common-sense notions of cause and effect - which perhaps makes the idea of something appearing from nothing a little easier to swallow.

Similar reasoning led Stephen Hawking to propose that black holes must emit a form of radiation - and we have good evidence that they do. Hawking radiation results from apparently empty space gaining some energy due to the uncertainty principle. This is converted into a pair of short-lived particles - one of normal matter and one of antimatter - that would usually annihilate each other moments after their creation. Near a black hole's event horizon, however, one can float away while the other is swallowed by the black hole. The gradual loss of the energy carried away by these particles will eventually lead to the complete evaporation of the black hole. Analogues of black holes created by shining laser light into a piece of glass have recreated this phenomenon (*New Scientist*, 2 October 2010, p 10) - adding plausibility to the argument that the universe created itself from nothing.

A fundamental limit of mathematics has offered a similarly rich vein of research material. In 1931, Kurt Gödel formulated his incompleteness theorem, which showed that certain mathematical systems cannot prove themselves to be true. Arithmetic, for example, is built on axioms - assumptions, essentially - that can't themselves be proven using arithmetic. That makes the entire edifice of arithmetic in some ways a mathematical equivalent of the sentence "this sentence is false". Other branches of mathematics face a similar problem.

Gödel's insight was a huge blow to the dream of building an unassailable mathematical foundation upon which our description of reality could be built - and it may also place a fundamental limit on how much trust

physicists can place in any theory they create. However, here too a limitation has been turned into a source of ideas.

The British mathematician Alan Turing, for example, used Gödel's work to uncover a fundamental characteristic of computing machines: that it is impossible to devise a method that can be applied to any program to predict whether or not it will finish its task and halt. Sometimes you just have to run the program and wait. This "halting problem" may seem arcane but it has come to play a fundamental role in mathematics and computer science. It has turned out to be equivalent to many other problems in pure mathematics, such as deciding whether a "Diophantine equation", a type of algebraic expression involving only whole numbers, has a solution or not. "It tells you when not to attempt the impossible," says Gregory Chaitin, a mathematician at IBM's Watson Research Center in Yorktown Heights, New York.

Just as the impossibility of building a perpetual motion machine led to the discovery of the laws of thermodynamics, the limits of mathematics and computing can teach us some basic rules about how the mathematical world works. "I used to be a pessimist about incompleteness, but not any more," Chaitin says. "You can say, 'Oh my god there's a wall', but you can also say, 'Look: there's a door in the wall'."

Chaitin is now applying incompleteness to evolution - something he calls "metabiology". The idea stems from his considerations of Turing's work. The halting problem led Chaitin to formulate a number, known as omega, that defines the probability of whether a randomly chosen program will halt or not in terms of a string of 0s and 1s. Omega is infinitely long and irreducibly complex, and Chaitin has described it as the DNA of mathematics. Now he is working out how to use omega to examine real DNA.

If you think of DNA as a program for building and operating an organism, Chaitin says, you might be able to discover the mathematics by which the information in DNA operates. Doing this, he says, may show that evolution is the analogue of omega: infinitely complex and thus endlessly creative. "A way of looking at Gödel and Turing's work is that they were opening the door from pure mathematics to biology," Chaitin says.

When it comes to biology, there is only one sure limit, according to evolutionary biologist Jerry Coyne of the University of Chicago. Knowing how life began will be forever beyond our reach, he says - it is biology's cosmic horizon. That is because the molecules involved didn't get fossilised. Even if we can create a "second genesis" in the laboratory, that won't tell us exactly how it happened on Earth 3.8 billion years ago, Coyne says. "There are so many different scenarios for how life got going and they all involve molecules that don't get fossilised. It's a clear limit."

Another area of biology that some say lies beyond the limits of science is consciousness. Decades have passed without any real progress, says Russell Stannard, emeritus professor of physics at the Open University in the UK, and author of *The End of Discovery*. That may mean it is beyond us, he concludes. "Consciousness is a very good candidate for us having exhausted all that can be said about it."

Philosopher Daniel Dennett of Tufts University in Medford, Massachusetts, doesn't buy this argument. "There are limits to science but this isn't one of them," he says. "I know of no reason to expect that a brain couldn't understand its own methods of functioning." Dennett also reckons that there is plenty of progress. "I can't keep up with it," he says. It's a tough problem to be sure, but the sceptics are seeing the problem from the wrong perspective. Just because the brain is complex, with 100 million cells and a quadrillion synaptic connections, that doesn't mean we can't figure out what is going on within it.

However complex the human brain, Dennett points out, we are quite capable of augmenting its capabilities in order to understand it. In the past we used conversations, books and letters; now we use computers to store, access and process vast amounts of data. We have become extremely successful at sharing that data too, in a way that connects many minds together to solve the toughest of questions. That is how we reached the point where we can understand and even predict the movement of stars and electrons. There is no reason to think consciousness cannot be conquered in the same way, Dennett says.

Science and technology don't just allow us to augment our brains and senses to see further. They can also open doors to worlds we can never directly experience. The early history of our cosmos is lost to us forever because it was only after 100,000 years that light became detached from matter and was free to fill the universe, carrying information with it. That hasn't stopped us from piecing together a detailed account of what happened before that time.

Don't underestimate science

A combination of creative thinking and rigorous checks against what information we do have available has proved an astonishingly powerful tool. While we will never know for sure that the big bang theory is correct,

we have lots of reasons to think it is. For example, the amounts of the elements hydrogen, helium and lithium present in the universe exactly match the predictions of our theories describing the beginning of everything.
It is also possible to use well-tested theories to see beyond what we can experience directly. For example, we have never carried out an experiment in a black hole and probably never will, but we can still be confident what happens inside one. "Einstein's theory of gravity has been tested in a number of ways, and therefore we take seriously what it has to say about the inside of black holes," Rees says.
Perhaps the biggest workaround will have to be in our search for a "theory of everything". The most promising candidate is string theory, which conjures what we think of as nature's fundamental forces and particles from the vibrations of tiny bundles of energy. Unfortunately, string theory only works if there are extra, unreachable dimensions of space. These dimensions are, string theorists suggest, "compactified" - rolled up too small for us to be able to interact with them.
Though we cannot access these dimensions, we already have circumstantial evidence that they exist. In 1999, for example, Lisa Randall and Raman Sundrum at Harvard University came up with an explanation for why the gravitational force is so much weaker than the other fundamental forces of nature. Their calculations looked at a five-dimensional universe and the way forces would manifest within it. They found that while electromagnetism and the strong and weak nuclear forces exert their full strength in all dimensions, gravity is strongly bound to the hidden fifth dimension and only a small fraction of it "leaks" into the four we inhabit. Is gravity's feebleness a result of hidden extra dimensions?
Proof of string theory faces other, even bigger obstacles. Even with the extra dimensions in place, there remains the problem of getting to the energies at which string theory could be tested. Probing things on such small scales requires working at extremely high energies - to smash them into ever-smaller pieces takes ever more energy. That is why particle accelerators need to get more powerful to delve deeper into the nature of matter. "To test string theory you'd need a collider the size of a galaxy," Stannard says. The chances of building such a machine are slim.
Yet there is still hope. Many of the equations governing high-energy physics turn out to be the same as those that govern the behaviour of electrons and other particles whizzing about within solids. That has led to suggestions that tabletop experiments on humble crystals might yield some of the answers we seek.
There are still doubters, of course. Some have suggested that our final theory would be so complex as to be beyond human comprehension, or even beyond human capabilities for discovering it. Mathematician Roger Penrose at the Univerity of Oxford thinks that unlikely, however. "I don't see why it should be," he says.
Marcelo Gleiser, a philosopher and physicist at Dartmouth College in New Hampshire, takes the opposite view. He has argued that the notion of a theory of everything rests on an unproven assumption that the universe is inherently neat and symmetrical. The very fact that the universe contains energy and matter is evidence against such symmetry, he says. Nothingness is neater than something, so the fact that the universe is full of stuff could mean that it is surprisingly messy at heart (*New Scientist*, 8 May 2010, p 28).
In the end, though, the consensus is that it is well worth pressing on. Thanks to the incompleteness theorem, we will never be sure any theory of everything is mathematically true, but that shouldn't bother us unduly. It didn't worry Gödel, who considered intuition more important than formal proof. Contemporary mathematicians are following suit, Chaitin says, and are throwing new, unprovable axioms into their subject all the time.
A little over 100 years ago, nobody had the slightest idea that the quantum world even existed. Now it lies at the heart of our understanding of the universe. Today's unknowns sometimes become tomorrow's great theories. A hundred years from now, who knows what we will know?
Rees remains circumspect, however. We can dream of a final theory, but we need to keep those chimps in mind, he says, even if the ultimate limits of science are not yet on our radar. "The limits won't necessarily be something we're struggling to solve now," he says. "It's not the unified theory. It's going to be a problem we are not even aware of."
***Michael Brooks** is a consultant for New Scientist and author of 13 Things that Don't Make Sense (Profile, 2008) and The Big Questions: Physics (Quercus, 2010)*

http://www.newscientist.com/article/mg21028111.200-the-limits-of-knowledge-things-well-never-understand.html

Beleaguered mission measures swirling space-time at last

- 21:51 04 May 2011 by **David Shiga**

Gravity Probe B has finally measured an effect called frame dragging (Image: Gravity Probe B/Stanford)

The beleaguered Gravity Probe B mission has finally measured a subtle effect of general relativity called frame dragging. The result comes nearly six years after it finished making measurements and years after other experiments measured the effect to greater precision.

NASA launched the $750 million mission in 2004 and it finished collecting data in September 2005. Its goal was to test Einstein's general theory of relativity, the currently accepted theory of gravity, by measuring subtle distortions in the fabric of space-time due to the Earth's gravitational field.

To achieve this, the Gravity Probe B spacecraft contained four superconducting niobium spheres about the size of ping pong balls. They were set spinning, and it was expected that their spin axis would change slightly over time as a result of these distortions.

But the data was much noisier than expected, making it initially difficult to detect these effects.

In April 2007, after more than a year of data analysis, the team reported detecting one such phenomenon, called the geodetic effect, which is due to the dent the Earth's gravity makes in space-time.

The second effect the mission was meant to measure proved much more elusive. As the Earth rotates, it drags the surrounding space around with it – a phenomenon known as frame dragging or the Lense-Thirring effect.

Swirling honey

"Imagine the Earth as if it were immersed in honey," says Francis Everitt of Stanford University in California, the mission's chief scientist. "As the planet rotates, the honey around it would swirl, and it's the same with space and time."

A 2008 NASA review was pessimistic about the prospects for detecting frame dragging in Gravity Probe B's noisy data. But data analysis continued with private funding, some arranged by the Saudi royal family.

Now, after further analysis of the data, Gravity Probe B scientists say they have detected frame-dragging with a precision of about 20 per cent.

Earlier results

"We have managed to test two of the most profound effects of general relativity and to do so in a new way," Everitt said in a NASA press conference on Wednesday.

This is the first time frame dragging has been measured in this way. But it was measured previously in 2004 to about 10 per cent precision by its effects on the orbits of the LAGEOS I and II satellites. Tracking the motion of the moon with lasers has also measured frame dragging to a precision of 0.1 per cent.

Given these earlier results, questions are likely to remain about the value of Gravity Probe B's contribution, but Everitt defended the mission's value. "The great beauty of it is that we have complementary tests of general relativity," he said."We completed this landmark experiment testing Einstein's universe ... and Einstein survives."

Journal reference: *Physical Review Letters* (forthcoming)

http://www.newscientist.com/article/dn20444-beleaguered-mission-measures-swirling-spacetime-at-last.html?full=true&print=true

Digital legacy: Respecting the digital dead

- Updated 10:47 06 May 2011 by **Sumit Paul-Choudhury**

It's what's inside that counts (Image: Rex Features)

Read more: "Digital legacy: The fate of your online soul"

At first glance, there's nothing remarkable about the computer desktop on the screen in front of me. Its slightly psychedelic wallpaper is half covered by standard, if slightly old-fashioned icons. Many have names that relate to genetic analysis, hinting at their owner's profession, while others are more obscure, perhaps relating to personal affairs. Feeling a bit like an intruder, I watch as folders open, documents pop up, applications start.

The desktop is not just anybody's. It was owned by the late evolutionary biologist Bill Hamilton. When he died, his family were at a loss as to what to do with his digital archives, so they passed them to his friend and former student Jeremy Leighton John, curator of e-manuscripts ("eMSS") at the British Library in London. Hamilton's is one of about a dozen digital legacies curated by John. He now heads the library's effort to understand the technical and ethical challenges associated with preserving such materials for posterity. That's becoming an increasingly pressing issue: last month, the library hit the headlines when it paid £32,000 to acquire 40,000 emails from the poet Wendy Cope, along with her digital archive

Copied computer

What John is showing me now in the library's eMSS lab is actually a simulation of Hamilton's computer. The actual machine is safe and secure in a vast storage area eight storeys below – and may in due course be returned to Hamilton's family or passed on to another institution.

Researchers who want to understand Hamilton's work will be able to use the simulation to explore his records and even re-enact his analyses without going near the machine. This elaborate arrangement is necessary, says John, because otherwise it's all too easy to contaminate the original data. "As soon as you turn a computer on, you start changing dates," he says. That could destroy clues that future researchers will need to piece together, such as the origins of a notable piece of work.

Not much software has yet been developed for the analysis of digital archives, so John has borrowed many techniques from digital forensics, which takes a similar approach: "Don't change the information; analyse the information without changing it; and show that you haven't changed it." Forensic tools, unlike standard-issue computer maintenance or disc analysis software, are built with these principles in mind – and observe them well enough for their findings to stand up in court.

Untouchable

But preserving all this material raises its own problems: what should be kept off-limits to researchers? Attitudes vary, says John. Just as some people don't mind having all of their papers open to scrutiny, there are some who are happy to let researchers look through all their digital data. But there are others who would rather have their privacy closely protected.

The problem is that few of us make the distinction between private and public as we store and label files – and given the vastness of our digital estates, it's unlikely that our inheritors will have the time to tidy them up for us. They may not even be able to: John recalls a family who donated a stack of 5¼-inch floppy discs to the library without any real idea of what they contained.

"Archivists tend to see themselves primarily as mediators between the creative individual – the originator of the archive – and the researcher," says John. "So the archivists help protect the privacy of the individual while helping to ensure the authenticity of the information on behalf of the researcher." That might include removing credit card numbers or telephone numbers before releasing the files; forensic software can be used to identify where such sensitive information exists.

In some cases, the creator or donor may prefer that some information be removed entirely, but that has its own complications. John has suggested that organisations like the British Library may need to provide donors with a copy of any digital object before they delete the donated copy, for whatever reason. That way, the library can delete material that seems irrelevant or personal without destroying the existing copy. "We wouldn't want to be blamed for deleting the last copy of one of Einstein's emails, as it were, whatever the justification might be," says John.

Tools for the job

John suggests that part of the solution is technological: we need better tools to help us curate our own data as we go along. "It's amazing that software companies haven't really got to grips with personal information management," he says. The files-and-folder system used by most of us has profound shortcomings, even when supplemented with powerful search capabilities: a third of participants in a recent survey conducted by the British Library and University College London reported a serious loss of data at home. Of these, more than two-thirds had simply misplaced files; hard drive failure, though much feared, accounted for less than a tenth of such losses. Tools that allow us to organise our data more intuitively would not only help to prevent such painful losses, but also make the work of archivists easier.

John, like many other archivists, hopes that standards will emerge that will make it comparatively easy to navigate, preserve and curate a digital bequest. In the past couple of years, this has gone from a theoretical to a practical concern, with John's eMSS lab sharing a floor with the library's digital preservation team and the Open Planets Foundation, a not-for-profit organisation dedicated to developing workaday digital archiving tools.

What might those look like? A promising two-pronged approach, says John, is to develop file formats and software that cater to the particular needs of archiving and preservation and can be run on "universal virtual machines". That would allow digital disc images, like that of Hamilton's Macintosh, to be booted up without being tied to any particular platform. The virtual machine can be repeatedly "ported" to newer machines, ensuring the files will remain accessible even as the original hardware becomes obsolete or unusable.

If all of that works, a researcher at the British Library may one day experience the spooky sensation of poking around my desktop long after I am gone. And perhaps yours too.

Sumit Paul-Choudhury *is the editor of newscientist.com*

http://www.newscientist.com/article/dn20445-digital-legacy-respecting-the-digital-dead.html

Immature Skull Led Young Tyrannosaurs to Rely on Speed, Agility to Catch Prey

Skull of a 2-year-old juvenile Tarbosaurus, a Cretaceous tyrannosaur from Mongolia. The skull is represented by a photograph (lower right), a drawing (center), and a computer rendering with rock removed based on CT scanning (top left). (Credit: Courtesy of the Hayashibara Museum of Natural Sciences and WitmerLab at Ohio University)

ScienceDaily (May 9, 2011) — While adult tyrannosaurs wielded power and size to kill large prey, youngsters used agility to hunt smaller game.

"It's one of the secrets of success for tyrannosaurs -- the different age groups weren't competing with each other for food because their diets shifted as they grew," said Ohio University paleontologist Lawrence Witmer.

Witmer is part of an international team of scientists from Japan, Mongolia and the United States that analyzed the youngest and most-complete known skull for any species of tyrannosaur, offering a new view of the growth and feeding strategies of these fearsome predators. The 70-million-year-old skull comes from a very young individual of the Mongolian dinosaur species known as *Tarbosaurus bataar*, the closest known relative of *T. rex*.

The analysis of the 11.4-inch skull, published in the *Journal of Vertebrate Paleontology*, revealed changes in skull structure that suggest that young tyrannosaurs had a different lifestyle than adults.

"We knew that adult Tarbosaurus were a lot like *T. rex*," said lead author Takanobu Tsuihiji, a former Ohio University postdoctoral fellow who is now a postdoctoral researcher at the National Museum of Nature and Science in Tokyo. "Adults show features throughout the skull associated with a powerful bite…large muscle attachments, bony buttresses, specialized teeth. The juvenile is so young that it doesn't really have any of these features yet, and so it must have been feeding quite differently from its parents."

The skull was found as part of an almost complete skeleton, missing only the neck and a portion of the tail. Based on careful analysis of the microstructure of the legs bones, co-author Andrew Lee of Ohio University (now at Midwestern University) estimated that the juvenile was only 2 to 3 years old when it died. It was about 9 feet in total length, about 3 feet high at the hip and weighed about 70 pounds. In comparison, Tarbosaurus adults were 35 to 40 feet long, 15 feet high, weighed about 6 tons and probably had a life expectancy of about 25 years, based on comparison with *T. rex*.

"This little guy may have been only 2 or 3, but it was no toddler…although it does give new meaning to the phrase 'terrible twos,'" said Witmer, Chang Professor of Paleontology at the Ohio University College of Osteopathic Medicine. "We don't know to what extent its parents were bringing it food, and so it was probably already a pretty capable hunter. Its skull wasn't as strong as the adult's, and would have had to have been a more careful hunter, using quickness and agility rather than raw power."

The different hunting strategies of juveniles and adults may have reduced competition among Tarbosaurus and strengthened their role as the dominant predators of their environment.

"The juvenile skull shows that there must have a change in dietary niches as the animals got older," Tsuihiji said. "The younger animals would have taken smaller prey that they could subdue without risking damage to their skulls, whereas the older animals and adults had progressively stronger skulls that would have allowed taking larger, more dangerous prey."
The late Cretaceous environment offered plenty of options for prey.
"Tarbosaurus is found in the same rocks as giant herbivorous dinosaurs like the long-necked sauropod Opisthocoelicaudia and the duckbill hadrosaur Saurolophus," said Mahito Watabe of the Hayashibara Museum of Natural Sciences in Okayama, who led the expedition to Mongolia in 2006 that uncovered the new skull. "But the young juvenile Tarbosaurus would have hunted smaller prey, perhaps something like the bony-headed dinosaur Prenocephale."
The juvenile skull also is important because it helps clarify the identity of small, potentially juvenile specimens of other tyrannosaur species previously found.
"The beauty of our new young skull is that we absolutely know for many good reasons that it's Tarbosaurus," Witmer said. "We can use this known growth series to get a better sense of whether some of these more controversial finds grew up to be Tarbosaurus, Tyrannosaurus or some other species."
Other authors on the article include Khishigjav Tsogtbaatar and Rinchen Barsbold of the Mongolian Paleontological Center; Takehisa Tsubamoto, Shigeru Suzuki and Yasuhiro Kawahara of the Hayashibara Biochemical Laboratories; and Ryan Ridgely of the WitmerLab at Ohio University. The research was funded by grants to Tsuihiji from the Japan Society of Promotion of Science and to Witmer and Ridgely from the U.S. National Science Foundation. The field work was supported by the Hayashibara Company Limited, Olympus, Mitsubishi Motor Company and Panasonic.

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

Journal Reference:

1. Tsuihiji, T., M. Watabe, K. Tsogtbaatar, T. Tsubamoto, R. Barsbold, S. Suzuki, A. H. Lee, R. C. Ridgely, Y. Kawahara, L. M. Witmer. **Cranial osteology of a juvenile specimen of Tarbosaurus bataar from the Nemegt Formation (Upper Cretaceous) of Bugin Tsav, Mongolia**. *Journal of Vertebrate Paleontology*, 2011; 31 (3): 1-21

http://www.sciencedaily.com/releases/2011/05/110509151236.htm

New Insect Repellant May Be Thousands of Times Stronger Than DEET

Anopheles mosquito, which can spread malaria. (Credit: © Kletr / Fotolia)

ScienceDaily (May 9, 2011) — Imagine an insect repellant that not only is thousands of times more effective than DEET -- the active ingredient in most commercial mosquito repellants -- but also works against all types of insects, including flies, moths and ants.

That possibility has been created by the discovery of a new class of insect repellant made in the laboratory of Vanderbilt Professor of Biological Sciences and Pharmacology Laurence Zwiebel and reported this week in the online Early Edition of the *Proceedings of the National Academy of Sciences*.

"It wasn't something we set out to find," said David Rinker, a graduate student who performed the study in collaboration with graduate student Gregory Pask and post-doctoral fellow Patrick Jones. "It was an anomaly that we noticed in our tests."

The tests were conducted as part of a major interdisciplinary research project to develop new ways to control the spread of malaria by disrupting a mosquito's sense of smell supported by the Grand Challenges in Global Health Initiative funded by the Foundation for the NIH through a grant from the Bill & Melinda Gates Foundation.

"It's too soon to determine whether this specific compound can act as the basis of a commercial product," Zwiebel cautioned. "But it is the first of its kind and, as such, can be used to develop other similar compounds that have characteristics appropriate for commercialization."

The discovery of this new class of repellant is based on insights that scientists have gained about the basic nature of the insect's sense of smell in the last few years. Although the mosquito's olfactory system is housed in its antennae, 10 years ago biologists thought that it worked in the same way at the molecular level as it does in mammals. A family of special proteins called odorant receptors, or ORs, sits on the surface of nerve cells in the nose of mammals and in the antennae of mosquitoes. When these receptors come into contact with smelly molecules, they trigger the nerves signaling the detection of specific odors.

In the last few years, however, scientists have been surprised to learn that the olfactory system of mosquitoes and other insects is fundamentally different. In the insect system, conventional ORs do not act autonomously. Instead, they form a complex with a unique co-receptor (called Orco) that is also required to detect odorant molecules. ORs are spread all over the antennae and each responds to a different odor. To function, however, each OR must be connected to an Orco.

"Think of an OR as a microphone that can detect a single frequency," Zwiebel said. "On her antenna the mosquito has dozens of types of these microphones, each tuned to a specific frequency. Orco acts as the switch in each microphone that tells the brain when there is a signal. When a mosquito smells an odor, the microphone tuned to that smell will turn "on" its Orco switch. The other microphones remain off. However, by stimulating Orco directly we can turn them all on at once. This would effectively overload the mosquito's sense of smell and shut down her ability to find blood."

Because the researchers couldn't predict what chemicals might modulate OR-Orco complexes, they decided to "throw the kitchen sink" at the problem. Through their affiliation with Vanderbilt's Institute of Chemical Biology, they gained access to Vanderbilt's high throughput screening facility, a technology intended for the drug discovery process, not for the screening of insect ORs.

Jones used genetic engineering techniques to insert mosquito odorant receptors into the human embryonic kidney cells used in the screening process. Rinker tested these cells against a commercial library of 118,000 small molecules normally used in drug development. They expected to find, and did find, a number of compounds that triggered a response in the conventional mosquito ORs they were screening, but they were surprised to find one compound that consistently triggered OR-Orco complexes, leading them to conclude that they had discovered the first molecule that directly stimulates the Orco co-receptor. They have named the compound VUAA1.

Although it is not an odorant molecule, the researchers determined that VUAA1 activates insect OR-Orco complexes in a manner similar to a typical odorant molecule. Jones also verified that mosquitoes respond to exposure to VUAA1, a crucial step in demonstrating that VUAA1 can affect a mosquito's behavior.

"If a compound like VUAA1 can activate every mosquito OR at once, then it could overwhelm the insect's sense of smell, creating a repellant effect akin to stepping onto an elevator with someone wearing too much perfume, except this would be far worse for the mosquito," Jones said.

The researchers have just begun behavioral studies with the compound. In preliminary tests with mosquitoes, they have found that VUAA1 is thousands of times more effective than DEET.

They have also established that the compound stimulates the OR-Orco complexes of flies, moths and ants. As a result, "VUAA1 opens the door for the development of an entirely new class of agents, which could be used not only to disrupt disease vectors, but also the nuisance insects in your backyard or the agricultural pests in your crops," Jones said.

Many questions must be answered before VUAA1 can be considered for commercial applications. Zwiebel's team is currently working with researchers in Vanderbilt's Drug Discovery Program to pare away the parts of VUAA1 that don't contribute to its activity. Once that is done, they will begin testing its toxicity.

Vanderbilt University has filed for a patent on this class of compounds and is talking with potential corporate licensees interested in incorporating them into commercial products, with special focus on development of products to reduce the spread of malaria in the developing world.

Story Source:

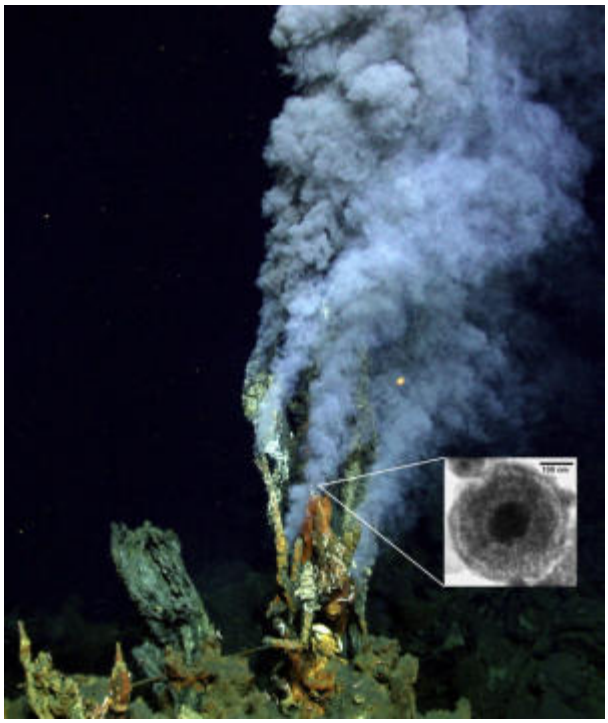
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Vanderbilt University**. The original article was written by David Salisbury.

Journal Reference:

1. Patrick L. Jones, Gregory M. Pask, David C. Rinker, Laurence J. Zwiebel. **Functional agonism of insect odorant receptor ion channels**. *Proceedings of the National Academy of Sciences*, 2011; DOI: 10.1073/pnas.1102425108

http://www.sciencedaily.com/releases/2011/05/110509151244.htm

'Fool's Gold' Is Ocean Life's Fertilizer: Pyrite Nanoparticles from Hydrothermal Vents Are Rich Source of Iron in Deep Sea



Black smoker from the Mariner vent site in the Pacific Ocean's Eastern Lau Spreading Center. (Credit: University of Delaware)

ScienceDaily (May 9, 2011) — Similar to humans, the bacteria and tiny plants living in the ocean need iron for energy and growth. But their situation is quite different from ours--for one, they can't turn to natural iron sources like leafy greens or red meat for a pick-me-up.

So, from where does their iron come?

New research results published in the current issue of the journal Nature Geoscience point to a source on the seafloor: minute particles of pyrite, or fool's gold, from hydrothermal vents at the bottom of the ocean.

Scientists already knew the vents' cloudy plumes, which spew forth from Earth's interior, include pyrite particles, but thought they were solids that settled back on the ocean bottom.

Now, scientists at the University of Delaware and other institutions have shown the vents emit a significant amount of microscopic pyrite particles that have a diameter 1,000 times smaller than that of a human hair.

Because the nanoparticles are so small, they are dispersed into the ocean rather than falling to the sea floor.

Barbara Ransom, program director in the National Science Foundation's (NSF) Division of Ocean Sciences, which funded the research, called the discovery "very exciting."

"These particles have long residence times in the ocean and can travel long distances from their sources, forming a potentially important food source for life in the deep sea," she said.

The project also received support from another NSF program, the Experimental Program to Stimulate Competitive Research, or EPSCOR.

The mineral pyrite, or iron pyrite, has a metallic luster and brass-yellow color that led to its nickname: fool's gold. In fact, pyrite is sometimes found in association with small quantities of gold.

Scientist George Luther of the University of Delaware explained the importance of the lengthy amount of time pyrite exists suspended in its current form in the sea, also known as its residence time.

Pyrite, which consists of iron and sulfur as iron disulfide, does not rapidly react with oxygen in seawater to form oxidized iron, or "rust," allowing it to stay intact and move throughout the ocean better than other forms of iron.

"As pyrite travels from the vents to the ocean interior and toward the surface ocean, it oxidizes gradually to release iron, which becomes available in areas where iron is depleted so that organisms can assimilate it, then grow," Luther said.
"It's an ongoing iron supplement for the ocean--much as multivitamins are for humans."
Growth of tiny plants known as phytoplankton can affect atmospheric oxygen and carbon dioxide levels.
Much of the research was performed by scientist and lead author Mustafa Yucel of the Universite Pierre et Marie Curie in France, conducted while Yucel worked on a doctorate at the University of Delaware.
It involved scientific cruises to the South Pacific and East Pacific Rise using the manned deep-sea submersible Alvin and the remotely operated vehicle Jason, both operated by the Woods Hole Oceanographic Institution.
Co-authors, in addition to Yucel and Luther, are Amy Gartman and Clara Chan, also of the University of Delaware.

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

Journal Reference:

1. Mustafa Yücel, Amy Gartman, Clara S. Chan, George W. Luther. **Hydrothermal vents as a kinetically stable source of iron-sulphide-bearing nanoparticles to the ocean**. *Nature Geoscience*, 2011; DOI: 10.1038/ngeo1148

http://www.sciencedaily.com/releases/2011/05/110509151304.htm

Genome of Marine Organism Reveals Hidden Secrets; New Methods to Identify Promising Species in the Wild

Adam Jones collects samples in Papua New Guinea. (Credit: Scripps Institution of Oceanography, UC San Diego)

ScienceDaily (May 9, 2011) — An international team of researchers led by scientists at Scripps Institution of Oceanography at UC San Diego has deciphered the genome of a tropical marine organism known to produce substances potentially useful against human diseases.

Tiny photosynthetic microorganisms called cyanobacteria are some of the oldest forms of life on the planet. At times their emergence as toxic blooms causes a threat to humans and animals. But despite the recognized capability of marine strains of the cyanobacterial genus Lyngbya, and specifically the species *L. majuscula*, to create hundreds of natural products with biomedical promise, surprisingly little is known about the genetics underlying their production.

In this week's online early edition of the *Proceedings of the National Academy of Sciences*, a research team led by Scripps graduate student Adam Jones and postdoctoral fellow Emily Monroe, both in the Gerwick laboratory at Scripps Institution of Oceanography's Center for Marine Biotechnology and Biomedicine (CMBB), provide the first insights of the genome of *Lyngbya majuscula* 3L, a Caribbean organism that generates compounds that are being developed for potential treatment against cancer and neurodegenerative diseases.

"These compounds have gained considerable attention due to their pharmaceutical and biotechnology potential, but they are also notorious for their environmental toxicity and threats to humans, wildlife and livestock," the authors note in their paper.

In the marine environment the wiry, or "filamentous," cyanobacteria play a vital role in the global carbon cycle. Lyngbya strains are known to disrupt the healthy growth of coral reefs and are behind the agents responsible for a skin rash known as "swimmer's itch."

Achieving the first genomic sequencing of its kind for the filamentous *Lyngbya majuscula* 3L, the research team overcame several obstacles due to the organism's complex, intermeshed growth in the wild with a range of other bacteria, muddying a clear picture of the genome. The team undertook several different research tactics and experiments, including single cell genome amplification, protein and metabolite profiling.

The results revealed a complex gene network suggesting an enhanced ability of the organism to adapt to shifting conditions in the marine environment.

Sequencing was done at the Max Planck Institute in Berlin, Germany and at the J.Craig Venter Institute in Rockville, Maryland. Much of the assembly was conducted by Sheila Podell, a project scientist in the Eric Allen laboratory at Scripps. Jones and Monroe traced the genomic pathways and performed tests to understand which genes encoded the production of different natural products.

Yet as much as the genome revealed about *Lyngbya majuscula* 3L, the researchers also uncovered key information about its limitations and shortcomings. For example, it's been assumed that *Lyngbya majuscula* 3L and its cousins in the Lyngbya genus convert, or "fix," nitrogen from the atmosphere into organic

molecules, a fundamental natural process in the global environment. To their surprise, *Lyngbya majuscula* 3L lacks the genes necessary for nitrogen fixation, even though reports exist that this species fixes nitrogen.
"It's possible that strains of *L. majuscula* reported to fix nitrogen may have been misidentified because it is visually very similar to other filamentous cyanobacteria species and we found that this marine strain doesn't seem capable of fixing nitrogen on its own," said Monroe. "This feature could be a distinction between the freshwater and the marine strains of what is currently characterized as Lyngbya.'"
And while marine Lyngbya strains are proven prolific generators of natural products with biomedical and pharmaceutical potential, the new study shows that more work is needed to pinpoint which species generates which natural products. Jones says that more than 250 compounds are attributed to marine Lyngbya strains. Of those, nearly three-quarters are linked to *Lyngbya majuscula*. However, the *Lyngbya majuscula* 3L strain was found to only produce a small number of natural products.
"This particular strain doesn't produce nearly as many (natural products) as we thought it might, which shows that many of the interesting molecules discovered to date are probably scattered among multiple organisms," said Jones. "The lesson learned is that not all marine Lyngbya strains are created equal."
"This may change the way we start looking at things in the field and give us new ways to identify organisms," said Lena Gerwick, the faculty member who organized this genomic project from the beginning. "We might be able to turn things around and use the compounds they make as a new way of determining what kinds of species they are."
The Network of Excellence in Marine Genomics Europe, the U.S. National Institutes of Health and California Sea Grant supported the research.
In addition to Jones, Monroe and L. Gerwick, coauthors of the paper include Sheila Podell, Eduardo Esquenazi, Eric Allen and William Gerwick of Scripps Institution of Oceanography; Wolfgang Hess of the University of Freiburg, Germany; Sven Klages and Michael Kube of the Max Planck Institute for Molecular Genetics, Germany; Sherry Niessen, Heather Hoover and John Yates III of The Scripps Research Institute; Michael Rothmann and Michael Burkart of the UCSD Department of Chemistry and Biochemistry; Roger Lasken of the J. Craig Venter Institute; Pieter Dorrestein of the UCSD Department of Chemistry and Biochemistry and Skaggs School of Pharmacy and Pharmaceutical Sciences and Richard Reinhardt of the Genome Centre Cologne at MPI for Plant Breeding Research, Germany.

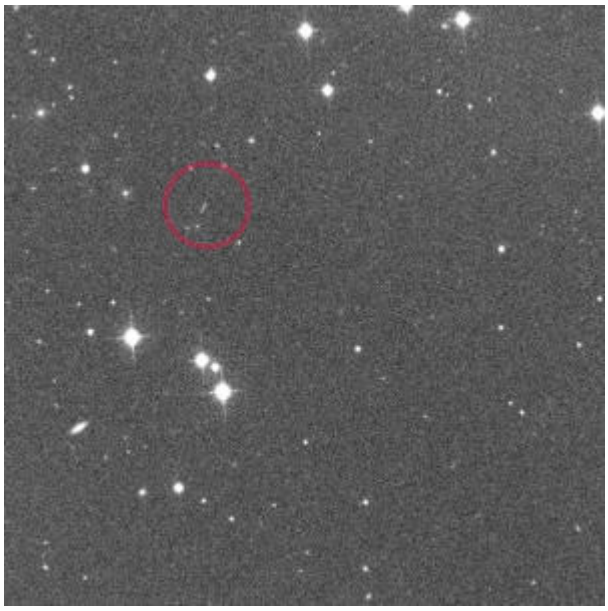
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Scripps Institution of Oceanography / University of California, San Diego**.

Journal Reference:

1. Adam C. Jones, Emily A. Monroe, Sheila Podell, Wolfgang R. Hess, Sven Klages, Eduardo Esquenazi, Sherry Niessen, Heather Hoover, Michael Rothmann, Roger S. Lasken, John R. Yates III, Richard Reinhardt, Michael Kube, Michael D. Burkart, Eric E. Allen, Pieter C. Dorrestein, William H. Gerwick, Lena Gerwick. **Genomic insights into the physiology and ecology of the marine filamentous cyanobacterium Lyngbya majuscula**. *Proceedings of the National Academy of Sciences*, 2011; DOI: 10.1073/pnas.1101137108

http://www.sciencedaily.com/releases/2011/05/110509171853.htm

Astronomers Find Newly Discovered Asteroid Is Earth's Companion



Astronomers used the Las Cumbres Observatory's Faulkes Telescope in England to track asteroid 2010 SO16, circled here in red. (Credit: Las Cumbres Observatory, Faulkes Telescopes)

ScienceDaily (May 9, 2011) — Astronomers from the Armagh Observatory in Northern Ireland have found that a recently discovered asteroid has been following Earth in its motion around the Sun for at least the past 250,000 years, and may be intimately related to the origin of our planet.

Their work appears in a paper in the journal *Monthly Notices of the Royal Astronomical Society.*

The asteroid first caught the eye of the scientists, Apostolos "Tolis" Christou and David Asher, two months after it was found by the WISE infrared survey satellite, launched in 2009 by the United States. "Its average distance from the Sun is identical to that of the Earth," says Dr Christou, "but what really impressed me at the time was how Earth-like its orbit was." Most near-Earth Asteroids -- NEAs for short -- have very eccentric, or egg-shaped, orbits that take the asteroid right through the inner solar system. But the new object, designated 2010 SO16, is different. Its orbit is almost circular so that it cannot come close to any other planet in the solar system except Earth.

The researchers set out to investigate how stable this orbit is and how long the asteroid has occupied it. To do that, they first had to take into account the current uncertainty in the asteroid's orbit. "Not knowing precisely the location of a newly-discovered NEA is quite common," explained Dr Asher. "The only way to eliminate the uncertainty is to keep tracking the asteroid for as long as possible, usually months or years." But the two scientists overcame that problem by creating virtual "clones" of the asteroid for every possible orbit that it could conceivably occupy. They then simulated the evolution of these clones under the gravity of the Sun and the planets for two million years into the past and in the future.

They found that all the clones remained in a so-called "horseshoe" state with respect to Earth. In this configuration, an object mimics very closely the orbital motion of our planet around the Sun, but as seen from Earth it appears to slowly trace out a horseshoe shape in space. Asteroid 2010 SO16 takes 175 years to make the trip from one end of the horseshoe to the other. So while on the one hand its orbit is remarkably similar to Earth's, in fact "this asteroid is terraphobic," explains Tolis. "It keeps well away from the Earth. So well, in fact, that it has likely been in this orbit for several hundred thousand years, never coming closer to our planet than 50 times the distance to the Moon." This is where it is now, near the end of the horseshoe trailing Earth.

Currently, three other horseshoe companions of Earth are known to exist but, unlike 2010 SO16, these linger for a few thousand years at most before moving on to different orbits. Also, with an estimated diameter of 200-400 metres, 2010 SO16 is by far the largest of Earth's horseshoe asteroids. The team have already used the Las Cumbres Observatory's Faulkes Telescope in an ongoing campaign to track the object and refine its

orbit further. "It is not that difficult to spot with a medium-sized professional telescope," says Dr Asher. "It will remain as an evening object in Earth's skies for many years to come."
Ultimately, Christou and Asher would like to know where it came from, and they have already thought of several possibilities. It could be an ordinary asteroid coming from the Main Belt between Mars and Jupiter. In that case, the random gravitational pull of the different planets would be responsible for its present orbit; something that Tolis and David think is an unlikely proposition. It could also be a piece of the Moon that escaped the gravity of Earth-Moon system and went into an independent orbit around the Sun. However, the very stability of its orbit means that there is currently no way to transport it from the Moon to where it is now. Finally, 2010 SO16 could represent leakage from a population of objects near the so-called triangular equilibrium points 60 degrees ahead of and behind Earth in its orbit. Such a population has been postulated in the past but never observed as such objects are always near the Sun in the sky. If they do exist, they may represent relic material from the formation of Earth, Moon and the other inner planets 4.5 billion years ago. For the time being, the astronomers would like to see the physical properties of the object studied from the ground, especially its colour. "Colour, a measure of an asteroid's reflectivity across the electromagnetic spectrum, can tell you a lot about its origin," they explain. "With this information we can start testing possible origin scenarios with hard data. If it proves to be unique in some way, it may be worth sending a probe to study it up close, and perhaps bring back a sample for laboratory scrutiny."

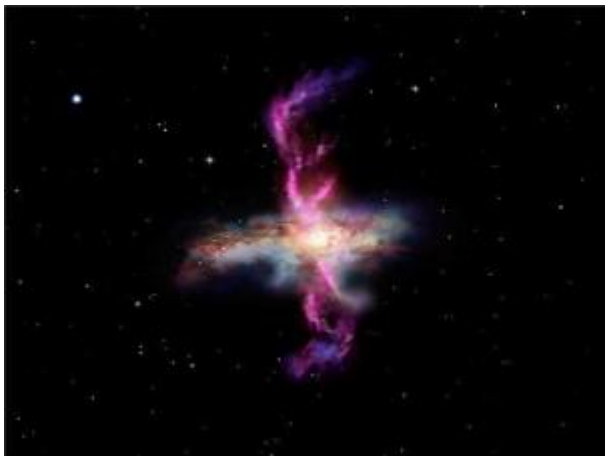
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Royal Astronomical Society (RAS)**.

Journal Reference:

1. A. A. Christou and D. J. Asher. **A long-lived horseshoe companion to the Earth**. *Monthly Notices of the Royal Astronomical Society*, 2011; (accepted) [link]

http://www.sciencedaily.com/releases/2011/04/110406132024.htm

Caught in the Act: Herschel Detects Gigantic Storms Sweeping Entire Galaxies Clean



This illustration shows an Ultra-Luminous InfraRed Galaxy (ULIRG) that exhibits massive outflows of molecular gas. (Credit: ESA/AOES Medialab)

ScienceDaily (May 9, 2011) — With observations from the PACS instrument on board the ESA Herschel space observatory, an international team of scientists led by the Max Planck Institute for Extraterrestrial Physics has found gigantic storms of molecular gas gusting in the centres of many galaxies.

Some of these massive outflows reach velocities of more than 1000 kilometres per second, i.e. thousands of times faster than in terrestrial hurricanes. The observations show that the more active galaxies contain stronger winds, which can blow away the entire gas reservoir in a galaxy, thereby inhibiting both further star formation and the growth of the central black hole. This finding is the first conclusive evidence for the importance of galactic winds in the evolution of galaxies.

In the distant and therefore younger Universe, many galaxies show much more activity than our Milky Way today. In commonly accepted evolutionary scenarios gas-rich galaxies merge, which triggers increased star formation ("starburst" galaxies) as well as the growth of supermassive black holes at their centres. This increased activity, however, seems to cease fairly suddenly, effectively stalling star formation and further growth of the black hole in as little as a few million years' time. What processes could be responsible for removing all the raw material powering this activity -- around a billion solar masses -- in such a (cosmologically) short timespan?

The solution to this riddle could be powerful winds that blow gas outwards from the centre of the galaxy. Powered by newly formed stars, shocks from stellar explosions or by the Black Hole in the galaxy's centre, these storms would remove all the gas supply from the galaxy thereby halting the same mechanisms that produced them in the first place.

"Outflows are key features in models of galactic formation and evolution, but prior to our work no decisive evidence of their active role in such processes had been gathered," explains Eckhard Sturm from the Max Planck Institute for Extraterrestrial Physics (MPE). Sturm led a study of ultra-luminous infrared galaxies with the PACS instrument on board the Herschel space observatory, which revealed massive outflows of molecular gas. Almost all previous observations dealt mainly with neutral and ionised gas, which does not contribute to the formation of stars.

"By detecting outflows in cold molecular gas from which stars are born, we can finally witness their direct impact on star formation," Sturm adds. "Star formation stalls as the gas supply is blown out of the centres of the galaxies with a rate of up to a thousand solar masses per year."

However, the observations not only reveal an intermediate stage of galaxy evolution, from disc galaxies with many young stars and a large gas fraction to elliptical galaxies with old stellar populations and little gas. In addition, they can explain another empirical property: The mass of the Black Hole in the centre and the mass of stars in the inner regions of a galaxy seem to correlate. Such a correlation is a natural consequence of the newly found galactic outflows as they remove the common gas reservoir thus inhibiting both star formation and the growth of the Black Hole.

"Herschel's sensitivity enabled us to detect these gigantic galactic storms, and to demonstrate, for the first time, that they may be strong enough to shut down stellar production entirely," says co-author Albrecht Poglitsch, also from MPE and the Principal Investigator of PACS.
The sample of galaxies observed is still too small to pin down the driving force behind these outflows. The first results seem to indicate that the galaxies fall in two categories: starburst-dominated objects loose material of up to a few hundred solar masses per year which is similar to their star formation rate; with velocities of a few hundred kilometres per second these outflows are probably driven by radiation pressure from starbursts or supernovae explosions. Galaxies dominated by the activity of the black hole in their centre loose material at much higher rates, up to a thousand solar masses per year or more; with velocities around 1000 kilometres per second these outflows are probably powered mostly by radiation pressure from the active galactic nucleus. To confirm these first conclusions and study potential trends in the outflow characteristics, the Herschel-PACS observations will continue to cover a much larger sample of galaxies.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Max-Planck-Institut für extraterrestrische Physik (MPE)**, via AlphaGalileo.

Journal Reference:

1. E. Sturm, E. González-Alfonso, S. Veilleux, J. Fischer, J. Graciá-Carpio, S. Hailey-Dunsheath, A. Contursi, A. Poglitsch, A. Sternberg, R. Davies, R. Genzel, D. Lutz, L. Tacconi, A. Verma, R. Maiolino, J. A. de Jong. **Massive molecular outflows and negative feedback in ULIRGs observed by Herschel-PACS**. *The Astrophysical Journal*, 2011; 733 (1): L16 DOI: 10.1088/2041-8205/733/1/L16

http://www.sciencedaily.com/releases/2011/05/110509091415.htm

In a Genetic Research First, Researchers Turn Zebrafish Genes Off and on

Researchers have succeeded in switching individual genes off and on in zebrafish, then observing embryonic and juvenile development. (Credit: iStockphoto)

ScienceDaily (May 9, 2011) — Mayo Clinic researchers have designed a new tool for identifying protein function from genetic code. A team led by Stephen Ekker, Ph.D., succeeded in switching individual genes off and on in zebrafish, then observing embryonic and juvenile development. The study appears in the journal *Nature Methods*.

The work could help shed light on health-related problems such as how cancerous cells spread, what makes some people more prone to heart attacks, or how genes factor in addiction. More complicated issues, like the genetics of behavior, plasticity and cellular memory, stress, learning and epigenetics, could also be studied with this method.

The research at Mayo Clinic's Zebrafish Core Facility could help further unify biology and genomics by describing the complex interrelations of DNA, gene function and gene-protein expression and migration. The study examines protein expression and function from 350 loci among the zebrafish's approximately 25,000 protein-encoding genes. Researchers plan to identify another 2,000 loci.

"I consider this particular system a toolbox for answering fundamental scientific questions," says Dr. Ekker, a Mayo Clinic molecular biologist and lead author of the article. "This opens up the door to a segment of biology that has been impossible or impractical with existing genomics research methods."

For the First Time

The study includes several technical firsts in genetic research. Those include a highly effective and reversible insertional transposon mutagen. In nearly all loci tested, endogenous expression knockdown topped 99 percent.

The research yielded the first collection of conditional mutant alleles outside the mouse; unlike popular mouse conditional alleles that are switched from "on" to "off," zebrafish mutants conditionally go from "off" to "on," offering new insight into localized gene requirements. The transposon system results in fluorescence-tagged mutant chromosomes, opening the door to an array of new genetic screens that are difficult or impossible to conduct using more traditional mutagenesis methods, such as chemical or retroviral insertion.

The project also marks the first in vivo mutant protein trap in a vertebrate. Leveraging the natural transparency of the zebrafish larvae lets researchers document gene function and protein dynamics and trafficking for each protein-trapped locus. The research also ties gene/protein expression to function in a single system, providing a direct link among sequence, expression and function for each genetic locus. Researchers plan to integrate information from this study into a gene codex that could serve as a reference for information stored on the vertebrate genome.

Shedding Light on Disease

Researchers exposed translucent zebrafish to transposons, "jumping genes" that move around inside the genome of a cell. The transposons instructed zebrafish cells to mark mutated proteins with a fluorescent protein 'tag.'

"This makes investigation of a whole new set of issues possible," Dr. Ekker says. "It adds an additional level of complexity to the genome project."

Dr. Ekker's team maintains about 50,000 fish in the Zebrafish Core Facility. To observe, photograph and document mutations of that many minnow-sized fish, the team works with an international team of researchers and gets helps from Rochester public elementary school teachers. Under a program with Mayo Clinic and Winona State University called InSciEd Out (Integrated Science Education Outreach), teachers document mutations and learn about the scientific method.
Other members of the research team include Karl Clark, Ph.D.; Yonghe Ding, Ph.D.; Stephanie Westcot; Victoria Bedell; Tammy Greenwood; Mark Urban; Kimberly Skuster; Andrew Petzold, Ph.D.; Jun Ni, Ph.D.; and Xiaolei Xu, Ph.D., all of Mayo Clinic; Darius Balciunas, Ph.D.; Aubrey Nielsen; and Sridhar Sivasubbu, Ph.D., all of the University of Minnesota; Hans-Martin Pogoda, Ph.D., and Matthias Hammerschmidt, Ph.D., of the University of Cologne in Germany; and Ashok Patowary and Vinod Scaria, Ph.D., of the Institute of Genomic and Integrative Biology in New Delhi.
The National Institute on Drug Abuse, National Institute of General Medical Sciences, National Institute of Diabetes and Digestive and Kidney Diseases, and Mayo Clinic funded the study.

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

Journal Reference:

1. Karl J Clark, Darius Balciunas, Hans-Martin Pogoda, Yonghe Ding, Stephanie E Westcot, Victoria M Bedell, Tammy M Greenwood, Mark D Urban, Kimberly J Skuster, Andrew M Petzold, Jun Ni, Aubrey L Nielsen, Ashok Patowary, Vinod Scaria, Sridhar Sivasubbu, Xiaolei Xu, Matthias Hammerschmidt, Stephen C Ekker. **In vivo protein trapping produces a functional expression codex of the vertebrate proteome**. *Nature Methods*, 2011; DOI: 10.1038/nmeth.1606

http://www.sciencedaily.com/releases/2011/05/110508134922.htm

Zombie Ants Have Fungus on the Brain, New Research Reveals

This is a dead carpenter ant attached to a leaf in the understory of a Thai forest. Before killing the ant, the fungus growing from ant's head changed the ant's behavior, causing it to bite into the leaf vein. (Credit: David Hughes, Penn State University)

ScienceDaily (May 9, 2011) — New research has revealed how infection by a parasitic fungus dramatically changes the behavior of tropical of carpenter ants (species *Camponotus leonardi*), causing them to become zombie-like and to die at a spot that has optimal reproduction conditions for the fungus. The multinational research team studied ants living high up in the rainforest canopy in Thailand.

A paper describing the research will be published in the BioMed Central open-access journal *BMC Ecology* on 9 May 2011.

"The behavior of these infected zombie ants essentially causes their bodies to become an extension of the fungus's own phenotype, as non-infected ants never behave in this way," said David P. Hughes, the first author of the research paper and an assistant professor of entomology and biology at Penn State University.

Using transmission-electron and light microscopes, the researchers were able to look inside the ant in order to determine the effect of the fungus on the ant. They found that the growing fungus fills the ant's body and head, causing muscles to atrophy and forcing muscle fibres to spread apart. The fungus also affects the ant's central nervous system. The scientists observed that, while normal worker ants rarely left the trail, zombie ants walked in a random manner, unable to find their way home. The ants also suffered convulsions, which caused them to fall to the ground. Once on the ground, the ants were unable to find their way back to the canopy and remained at the lower, leafy understory area which, at about 9 or 10 inches (25 cm) above the soil, was cooler and moister than the canopy, provided ideal conditions for the fungus to thrive.

The scientists found that at solar noon, when the Sun is at its strongest, the fungus synchronised ant behavior, forcing infected ants to bite the main vein on the underside of a leaf. The multiplying fungal cells in the ant's head cause fibres within the muscles that open and close the ant's mandibles to become detached, causing "lock jaw," which makes an infected ant unable to release the leaf, even after death. A few days later, the fungus grows through the ant's head a fruiting body, a stroma, which releases spores to be picked up by another wandering ant.

"The fungus attacks the ants on two fronts: first by using the ant as a walking food source, and second by damaging muscle and the ant's central nervous system," Hughes said. "The result for the ant is zombie walking and the death bite, which place the ant in the cool, damp understory. Together these events provide the perfect environment for fungal growth and reproduction."

Hughes said his continuing research at Penn State is designed to learn how the fungus might be used to control pest insects in homes and farms.

In addition to Hughes, other members of the research team include Sandra Andersen and Jacobus J Boomsma in Denmark, Nigel L Hywel-Jones and Winanda Himaman in Thailand, and Johan Billen in Belgium. This research was funded by a Marie Curie Individual Fellowship to David Hughes.

Story Source:

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

Journal Reference:

1. David P Hughes, Sandra Andersen, Nigel L Hywel-Jones, Winanda Himaman, Johan Billen and Jacobus J Boomsma. **Behavioral mechanisms and morphological symptoms of zombie ants dying from fungal infection**. *BMC Ecology*, 2011; DOI: 10.1186/1472-6785-11-13

http://www.sciencedaily.com/releases/2011/05/110509065536.htm

Brain Region That Influences Gambling Decisions Pinpointed

Researchers have found a difference in activity in a region of the brain that influences gambling decisions. (Credit: © Aliaksandr Zabudzko / Fotolia)

ScienceDaily (May 9, 2011) — When a group of gamblers gather around a roulette table, individual players are likely to have different reasons for betting on certain numbers. Some may play a "lucky" number that has given them positive results in the past -- a strategy called reinforcement learning. Others may check out the recent history of winning colors or numbers to try and decipher a pattern. Betting on the belief that a certain outcome is "due" based on past events is called the gambler's fallacy.

Recently, researchers at the California Institute of Technology (Caltech) and Ireland's Trinity College Dublin hedged their bets -- and came out winners -- when they proposed that a certain region of the brain drives these different types of decision-making behaviors.

"Through our study, we found a difference in activity in a region of the brain called the dorsal striatum depending on whether people were choosing according to reinforcement learning or the gambler's fallacy," says John O'Doherty, professor of psychology at Caltech and adjunct professor of psychology at Trinity College Dublin. "This finding suggests that the dorsal striatum is particularly involved in driving reinforcement-learning behaviors."

In addition, the work, described in the April 27 issue of The *Journal of Neuroscience*, suggests that people who choose based on the gambler's fallacy may be doing so because at the time of the choice they are not taking into account what they had previously learned or observed.

The focus of O'Doherty's research is to understand the brain mechanisms that underlie the decisions people make in the real world. To study this kind of decision making in the lab, his team gets study participants to play simple games in which they make choices that result in winning or losing small amounts of money. To make these games interesting, the researchers often present simple "gambling" scenarios, such as playing slot machines or roulette.

"For this particular study, we were interested in what part of the brain might play a role in controlling these strategies that drive behavior," says O'Doherty, who conducted the study along with postdoctoral scholar Ryan Jessup.

The team asked 31 participants to complete four roulette-wheel tasks while lying in an MRI scanner. For each round, the volunteers were asked to choose a color on a tricolored spinning wheel. If the wheel stopped on their color, they won two euros. (The study was done at Trinity College Dublin.) For each round, participants were charged a half euro, regardless of the outcome. All the while, the researchers studied the brain activity of participants, with a focus on how they appeared to choose colors.

"The dorsal striatum was more active in people who, at the time of choice, chose in accordance with reinforcement-learning principles compared to when they chose according to the gambler's fallacy," says Jessup. "This suggests that the same region involved in learning is also used at the time of choice."

The two types of strategies are actually contradictory because in reinforcement-learning behavior, one would be more likely to choose something if it has won a lot recently, and less likely to choose something if it has lost a lot recently. The opposite is true of the gambler's fallacy.

"The task was novel because making decisions based on either reinforcement learning or the gambler's fallacy is not rational in this particular task, and yet most of the subjects acted irrationally," explains Jessup. "Only 8 out of 31 subjects were generally rational, meaning they simply chose the color that covered the largest area in that round."

"It is very important to try to understand how interactions between different brain areas result in different types of decision-making behavior," says O'Doherty. "Once we understand the basic mechanisms in healthy people, we can start to look at how these systems go wrong in patients who suffer from different diseases, such as psychiatric disorders or addiction, that impact their decision-making capabilities."

The study, "Human Dorsal Striatal Activity during Choice Discriminates Reinforcement Learning Behavior from the Gambler's Fallacy," was supported by a Science Foundation Ireland grant.

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **California Institute of Technology**. The original article was written by Katie Neith.

Journal Reference:

1. R. K. Jessup, J. P. O'Doherty. **Human Dorsal Striatal Activity during Choice Discriminates Reinforcement Learning Behavior from the Gambler's Fallacy**. *Journal of Neuroscience*, 2011; 31 (17): 6296 DOI: 10.1523/JNEUROSCI.6421-10.2011

http://www.sciencedaily.com/releases/2011/05/110505103347.htm

Robotics: A Tiltable Head Could Improve the Ability of Undulating Robots to Navigate Disaster Debris

Using this robot, researchers at Georgia Tech were able to show that when its wedge-shaped head was set flat on the horizontal plane, negative lift force was generated and the robot moved downward into the medium. As the tip of the head was raised from zero to 7 degrees relative to the horizontal, the lift force increased until it became zero. At inclines above 7 degrees, the robot rose out of the medium. (Credit: Georgia Tech/Daniel Goldman)

ScienceDaily (May 9, 2011) — Search and rescue missions have followed each of the devastating earthquakes that hit Haiti, New Zealand and Japan during the past 18 months. Machines able to navigate through complex dirt and rubble environments could have helped rescuers after these natural disasters, but building such machines is challenging.

Researchers at the Georgia Institute of Technology recently built a robot that can penetrate and "swim" through granular material. In a new study, they show that varying the shape or adjusting the inclination of the robot's head affects the robot's movement in complex environments.

"We discovered that by changing the shape of the sand-swimming robot's head or by tilting its head up and down slightly, we could control the robot's vertical motion as it swam forward within a granular medium," said Daniel Goldman, an assistant professor in the Georgia Tech School of Physics.

Results of the study will be presented on May 10 at the 2011 IEEE International Conference on Robotics and Automation in Shanghai. Funding for this research was provided by the Burroughs Wellcome Fund, National Science Foundation and Army Research Laboratory.

The study was conducted by Goldman, bioengineering doctoral graduate Ryan Maladen, physics graduate student Yang Ding and physics undergraduate student Andrew Masse, all from Georgia Tech, and Northwestern University mechanical engineering adjunct professor Paul Umbanhowar.

"The biological inspiration for our sand-swimming robot is the sandfish lizard, which inhabits the Sahara desert in Africa and rapidly buries into and swims within sand," explained Goldman. "We were intrigued by the sandfish lizard's wedge-shaped head that forms an angle of 140 degrees with the horizontal plane, and we thought its head might be responsible for or be contributing to the animal's ability to maneuver in complex environments."

For their experiments, the researchers attached a wedge-shaped block of wood to the head of their robot, which was built with seven connected segments, powered by servo motors, packed in a latex sock and wrapped in a spandex swimsuit. The doorstop-shaped head -- which resembled the sandfish's head -- had a fixed lower length of approximately 4 inches, height of 2 inches and a tapered snout. The researchers examined whether the robot's vertical motion could be controlled simply by varying the inclination of the robot's head.

Before each experimental run in a test chamber filled with quarter-inch-diameter plastic spheres, the researchers submerged the robot a couple inches into the granular medium and leveled the surface. Then they tracked the robot's position until it reached the end of the container or swam to the surface.
The researchers investigated the vertical movement of the robot when its head was placed at five different degrees of inclination. They found that when the sandfish-inspired head with a leading edge that formed an angle of 155 degrees with the horizontal plane was set flat, negative lift force was generated and the robot moved downward into the media. As the tip of the head was raised from zero to 7 degrees relative to the horizontal, the lift force increased until it became zero. At inclines above 7 degrees, the robot rose out of the medium.
"The ability to control the vertical position of the robot by modulating its head inclination opens up avenues for further research into developing robots more capable of maneuvering in complex environments, like debris-filled areas produced by an earthquake or landslide," noted Goldman.
The robotics results matched the research team's findings from physics experiments and computational models designed to explore how head shape affects lift in granular media.
"While the lift forces of objects in air, such as airplanes, are well understood, our investigations into the lift forces of objects in granular media are some of the first ever," added Goldman.
For the physics experiments, the researchers dragged wedge-shaped blocks through a granular medium. Blocks with leading edges that formed angles with the horizontal plane of less than 90 degrees resembled upside-down doorstops, the block with a leading edge equal to 90 degrees was a square, and blocks with leading edges greater than 90 degrees resembled regular doorstops.
They found that blocks with leading edges that formed angles with the horizontal plane less than 80 degrees generated positive lift forces and wedges with leading edges greater than 120 degrees created negative lift. With leading edges between 80 and 120 degrees, the wedges did not generate vertical forces in the positive or negative direction.
Using a numerical simulation of object drag and building on the group's previous studies of lift and drag on flat plates in granular media, the researchers were able to describe the mechanism of force generation in detail.
"When the leading edge of the robot head was less than 90 degrees, the robot's head experienced a lift force as it moved forward, which resulted in a torque imbalance that caused the robot to pitch and rise to the surface," explained Goldman.
Since this study, the researchers have attached a wedge-shaped head on the robot that can be dynamically modulated to specific angles. With this improvement, the researchers found that the direction of movement of the robot is sensitive to slight changes in orientation of the head, further validating the results from their physics experiments and computational models.
Being able to precisely control the tilt of the head will allow the researchers to implement different strategies of head movement during burial and determine the best way to wiggle deep into sand. The researchers also plan to test the robot's ability to maneuver through material similar to the debris found after natural disasters and plan to examine whether the sandfish lizard adjusts its head inclination to ensure a straight motion as it dives into the sand.
This material is based on research sponsored by the Burroughs Wellcome Fund, the National Science Foundation (NSF) under Award Number PHY-0749991, and the Army Research Laboratory (ARL) under Cooperative Agreement Number W911NF-08-2-0004.

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

http://www.sciencedaily.com/releases/2011/05/110509151252.htm

Fundamental Question on How Life Started Solved: Supercomputer Calculates Carbon Nucleus

Periodic table detail for the element carbon. (Credit: iStockphoto/David Freund)

ScienceDaily (May 10, 2011) — For carbon, the basis of life, to be able to form in the stars, a certain state of the carbon nucleus plays an essential role. In cooperation with US colleagues, physicists from the University of Bonn and Ruhr-Universität Bochum have been able to calculate this legendary carbon nucleus, solving a problem that has kept science guessing for more than 50 years.

The researchers published their results in the coming issue of the scientific journal *Physical Review Letters*.

"Attempts to calculate the Hoyle state have been unsuccessful since 1954," said Professor Dr. Ulf-G. Meißner (Helmholtz-Institut für Strahlen- und Kernphysik der Universität Bonn). "But now, we have done it!" The Hoyle state is an energy-rich form of the carbon nucleus. It is the mountain pass over which all roads from one valley to the next lead: From the three nuclei of helium gas to the much larger carbon nucleus. This fusion reaction takes place in the hot interior of heavy stars. If the Hoyle state did not exist, only very little carbon or other higher elements such as oxygen, nitrogen and iron could have formed. Without this type of carbon nucleus, life probably also would not have been possible.

The search for the "slave transmitter"

The Hoyle state had been verified by experiments as early as 1954, but calculating it always failed. For this form of carbon consists of only three, very loosely linked helium nuclei -- more of a cloudy diffuse carbon nucleus. And it does not occur individually, only together with other forms of carbon. "This is as if you wanted to analyze a radio signal whose main transmitter and several slave transmitters are interfering with each other," explained Prof. Dr. Evgeny Epelbaum (Institute of Theoretical Physics II at Ruhr-Universität Bochum). The main transmitter is the stable carbon nucleus from which humans -- among others -- are made. "But we are interested in one of the unstable, energy-rich carbon nuclei; so we have to separate the weaker radio transmitter somehow from the dominant signal by means of a noise filter."

What made this possible was a new, improved calculating approach the researchers used that allowed calculating the forces between several nuclear particles more precisely than ever. And in JUGENE, the supercomputer at Forschungszentrum Jülich, a suitable tool was found. It took JUGENE almost a week of calculating. The results matched the experimental data so well that the researchers can be certain that they have indeed calculated the Hoyle state.

More about how the Universe came into existence

"Now we can analyze this exciting and essential form of the carbon nucleus in every detail," explained Prof. Meißner. "We will determine how big it is, and what its structure is. And it also means that we can now take a very close look at the entire chain of how elements are formed."

In future, this may even allow answering philosophical questions using science. For decades, the Hoyle state was a prime example for the theory that natural constants must have precisely their experimentally determined values, and not any different ones, since otherwise we would not be here to observe the Universe (the anthropic principle). "For the Hoyle state this means that it must have exactly the amount of energy it has, or else, we would not exist," said Prof. Meißner. "Now we can calculate whether -- in a changed world with

other parameters -- the Hoyle state would indeed have a different energy when comparing the mass of three helium nuclei." If this is so, this would confirm the anthropic principle.

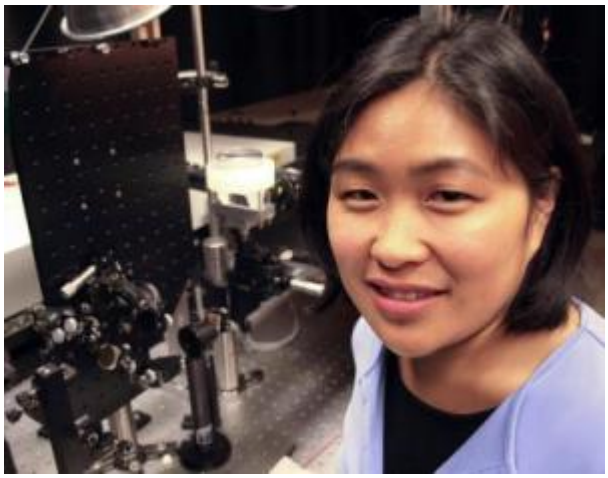
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of Bonn**.

Journal Reference:

1. Evgeny Epelbaum, Hermann Krebs, Dean Lee, Ulf-G. Meißner. **Ab Initio Calculation of the Hoyle State**. *Physical Review Letters*, 2011; 106 (19) DOI: 10.1103/PhysRevLett.106.192501

http://www.sciencedaily.com/releases/2011/05/110509113254.htm

Airborne Pollutants: New View of How Water and Sulfur Dioxide Mix



Stephanie T. Ota, a doctoral student at the University of Oregon, has completed experiments that show how surface water molecules, such as those on clouds, interact with sulfur dioxide at cool high-atmospheric temperatures. (Credit: University of Oregon)

ScienceDaily (May 10, 2011) — High in the sky, water in clouds can act as a temptress to lure airborne pollutants such as sulfur dioxide into reactive aqueous particulates. Although this behavior is not incorporated into today's climate-modeling scenarios, emerging research from the University of Oregon provides evidence that it should be.

The role of sulfur dioxide -- a pollutant of volcanic gasses and many combustion processes -- in acid rain is well known, but how sulfur dioxide reacts at the surface of aqueous particulates in the atmosphere to form acid rain is far from understood.

In National Science Foundation-funded laboratory experiments at the UO, chemistry doctoral student Stephanie T. Ota examined the behavior of sulfur dioxide as it approaches and adsorbs onto water at low temperatures that mimic high-atmospheric conditions. Using a combination of short-pulsed infrared and visible laser beams, she monitored the interaction of sulfur dioxide with water as it is flowed over a water surface.

The results -- detailed online ahead of regular publication in the *Journal of the American Chemical Society* -- show that as sulfur dioxide molecules approach the surface of water, they are captured by the top-most surface water molecules, an effect that is enhanced at cold temperatures.

Although this reaching out, says co-author Geraldine L. Richmond, professor of chemistry, provides a doorway for sulfur dioxide to enter the water solution, the weak nature of the surface-bonding interaction doesn't guarantee that the water temptress will be successful.

"We have found that that the sulfur dioxide bonding to the surface is highly reversible and does not necessarily provide the open doorway that might be expected," Ota said. "For example, for highly acidic water, the sulfur dioxide approaches and bonds to the water surface but shows little interest in going any further into the bulk water."

The uptake of gases like sulfur dioxide has important implications in understanding airborne pollutants and their role in global warming and climate change. Sulfur dioxide that has come together with water, becoming aqueous, reflects light coming toward the planet, while carbon dioxide accumulating in the atmosphere traps heat onto the planet.

Understanding the interaction of surface water molecules, such as those in clouds and fog, with pollutants rising from human activity below may help scientists better predict potential chemical reactions occurring in the atmosphere and their impacts, said Richmond, who was elected May 3 as a member of the National Academy of Sciences.

"In the past we presumed that most chemistry in the atmosphere occurred when gas molecules collide and react," she said. "These studies are some of the first to provide molecular insights into what happens when an

atmospherically important gas such as sulfur dioxide collides with a water surface, and the role that water plays in playing the temptress to foster reactivity."

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

Journal Reference:

1. Stephanie T. Ota, Geraldine L. Richmond. **Chilling Out: A Cool Aqueous Environment Promotes the Formation of Gas–Surface Complexes**. *Journal of the American Chemical Society*, 2011; : 110426082204049 DOI: 10.1021/ja201027k

http://www.sciencedaily.com/releases/2011/05/110509122735.htm

Pleasure Reading Leads to Professional Careers, Study Says

By Lauren Barack May 10, 2011

Teens who read for pleasure—rather than just for school work—are more likely to have professional careers as adults than those who don't crack open books for leisure, says a study conducted by the University of Oxford in the United Kingdom.

Researchers asked more than 17,000 people born in 1970 about how they spent their downtime when they were 16 years old and their careers when they turned 33. Girls who enjoyed reading had a 39 percent chance of finding a professional position, compared to 25 percent who didn't. Boys had a 58 percent chance if they were diving into books, compared to 48 percent who hadn't.

While bookworms, so to speak, have always been considered more studious and more likely to do well in school—and potentially in their careers—pinpointing how the ability to excel connects to reading hasn't always been exact.

"My only observation is that kids who read tend to be more intent on completing tasks because they can get back to their book," says Barbara Fecteau, a library media specialist with the Beverly High School in Beverly, MA. "This may or may not give them better focus. Also, being used to dropping into other lives and worlds in fiction definitely makes for a more creative thinker!"

Reading also showed up as a marker for increasing a student's likelihood of getting into college—raising a boy's chances to 35 percent from 24 percent and a girl's chances to 30 percent from 20 percent. For those who also took part in a cultural activity, such as playing the violin or visiting museums, their chances of getting into college jumped to 54 percent for boys and 48 percent for girls.

However, extracurricular activities didn't affect career success alone. Reading for fun, it seems, is the magic ingredient—something school librarians, teachers, and parents have long touted.

"According to our results, there is something special about reading for pleasure," says researcher Mark Taylor. "The positive associations of reading for pleasure aren't replicated in any other extracurricular activity, regardless of our expectations."

http://www.slj.com/slj/articlereview/890530-451/teens_who_read_for_pleasure.html.csp

Model of the Moment

May 9, 2011

The terms “outsourcing” and “workforce development” rarely appear as allies in the same sentence. At least not in Rust Belt states like Indiana, where the loss of manufacturing jobs has driven an increase in demand for postsecondary degrees that point to jobs that will not soon be exported overseas.

But Indiana’s leaders have embraced an outsourcing solution to the state's outsourcing problem. As Indiana faced down a challenge shared by many other states in the aftermath of 2008's financial bloodbath -- trying to increase capacity, especially for adult learners, at public universities while simultaneously gutting their budgets -- Gov. Mitch Daniels decided that, instead of paying to expand online programs at its existing state institutions, Indiana would contract with a private university outside its borders.

Enter Western Governors University, a private, nonprofit, regionally accredited institution headquartered in Salt Lake City, Utah. Founded in 1997 with seed money from the governors of 18 western states, Western Governors had been, until recently, a sleeping giant. But last June, Daniels signed an executive order bringing Western Governors into the fold as Indiana’s “eighth state university.” Under the deal, Western Governors would create WGU Indiana: a locally branded -- yet still remote, other than a new satellite office in Indianapolis -- version of the university, to which Hoosiers could take their state financial aid dollars just as they would to Indiana's other institutions. In late April, Washington State's legislature passed a law creating WGU Washington. Other states are rumored to be in talks to create similar partnerships, including California, Texas, Arizona, and Louisiana.

These arrangements are unusual beyond the oddity of anointing a Utah-based institution as a state university of Indiana and Washington. (Online education is common at public universities, and Indiana and Washington are no exceptions.) Rather, the main point of departure has to do with Western Governors’s pedagogical model, which focuses not only on teaching new skills but also on awarding credits for existing ones. No classes, no lectures, no fixed academic calendar. For what students can prove they already know, they get credit. For what they can't, they are given learning materials and some light guidance. Students are charged tuition every six months and take exams whenever they feel they are ready.

The model, called “competency-based learning,” has a number of champions in the policy world. The Council for Adult and Experiential Learning has advocated for "prior learning assessment" as a way of making sure students -- especially low-income ones -- do not pay any more to complete a degree than they have to. The Center for American Progress has praised Western Governors specifically as a beacon of innovation in an industry entrenched in the tyranny of the credit hour. The Stanford Research Institute recently rose to the defense of a competency-based associate degree program in nursing at Excelsior College, noting in an extensive study that its graduates are on par with those of more traditional programs.

But resistance to the model among educators in Washington and Indiana suggests that the Western Governors approach is not universally accepted. And with Western Governors looking to expand its state-by-state strategy, the concerns that have been raised in those states -- that Western Governors will not be held to the same standards of transparency and excellence as other public universities, that it will be taking student financial aid dollars that normally flow to truly in-state institutions, that it could create the illusion of addressing the capacity issue without really making much of a dent -- might foreshadow debates that could soon play out in legislatures across the country.

Competencies, not Courses

It is fair to say that the state-branded versions of Western Governors do not fit the mold of the traditional public university.

For one thing, students do not have professors. The university awards credit based on how well students can demonstrate "competencies" -- skills that students know already, from previous education or work experience, or should be able to learn without any real hand-holding. Its students, whose average age is 36, work through course material on their own, with occasional guidance from "mentors" (75 percent of whom hold graduate degrees) who advise them online or by phone every week or two.

The university's academic heavyweights are relegated to figuring out what students need to prove they have learned by the end of each unit, and designing exams accordingly. The total size of the full-time faculty is 700, according to WGU.

"We do not develop any of our own courses," says Bob Mendenhall, the president of Western Governors. "We develop the competencies required for a degree and the assessments to measure those competencies. Then our faculty go and find the best courses available to … teach that content." Western Governors licenses course modules from commercial providers such as Pearson and McGraw-Hill and borrows from open courseware sites, Mendenhall says.

Western Governors offers bachelor's and master's degrees (no associate degrees) in four general areas: business, education, health care, and information technology. Students do not need to wait until the end of a semester to take an exam; they can pay to take one at the nearest bricks-and-mortar testing center anytime they think they are ready. Beyond course materials, testing fees, and various other program-specific fees (some of which are $1,000 or more), the amount of tuition students pay depends on how much time it takes them to prepare for and complete all their exams. Tuition is a ticking clock: every six months, students are charged between $2,890 and $4,250, depending on the program.

In other words, students who know the most coming in, or are able to learn the quickest, will probably end up paying the least. Students who take longer -- because they are slow learners, or do not learn well on their own, or have especially demanding jobs or home lives, or are lazy, or some combination -- will probably end up paying the most. Five percent default on their student loans within two years.

Those who graduate take an average of 30 months, or five pay periods, to do so. Given the large number of nontraditional students at Western Governors -- the average age is 36, and two-thirds work full-time -- the university calculates its own graduation rate that, unlike the federal rate, includes part-time and non-first-time students. About 40 percent of Western Governors' students graduate within four years.

In its 2010 annual report, Western Governors emphasized students' high satisfaction with its curriculum: 72 percent of students stick with the program after a year; 96 percent say they are satisfied with their experience; 97 percent say they would recommend Western Governors to a friend. The university scores higher than average on the National Study of Student Engagement. In a recent survey (conducted by the university) of 120 employers, nearly 80 percent judged their employees who graduated from Western Governors to be equal to or better than their employees from other universities.

The media, too, has tended to focus on narratives that show how the university has enabled some students to pull themselves up by their bootstraps. In 2009, as part of a series called "What Works," "NBC Nightly News" aired a segment on Western Governors highlighting several success stories: an elementary school teacher in Miami who was able to get a graduate degree while tending to her two young children at home; a veteran computer specialist in Sacramento who had been "in and out of community college" for 20 years before finally finding, in Western Governors, a degree program that would allow him to get a degree necessary for a promotion "with very little studying."

But some of the 40 percent of students who end up graduating from the university can't relate.

Tima Huseman is among them. Huseman, 25, teaches second grade at a school outside Houston. Shortly after earning an undergraduate degree in early childhood education from Texas Tech University, Huseman enrolled in a master's program at Western Governors with a focus on K-8 math education. She graduated promptly and is well on her way to paying back the $12,000 she took on in debt.

There's only one problem, Huseman says: "I didn't learn anything to further my teaching."

The first three months were great, says Huseman. "You watch videos, you have to do worksheets, you plan lessons," she says -- exercises she felt were actually helping her become a better teacher. But the subsequent 14 months were devoted to a research paper that Huseman felt was too narrow and theory-based to have any practical application. She had expected more in the way of teaching strategies. The process of collecting data and drafting her paper made her a better writer and researcher, she says, but not a better teacher.

"I felt like I wasn't learning anything, but I stayed because I didn't want to waste the money I had spent already," Huseman says, adding that her mentor had to talk her out of quitting on three separate occasions.

While she liked her mentor, whom she spoke to every few weeks by phone, Huseman found the "hands-off" model off-putting, and even a bit disturbing. "No one comes to check on you. I know they can't have people everywhere, but I don't know -- I could literally have made up everything."

Huseman is just one story, no more or less valid than the more uplifting ones from the NBC segment. But the contrast of her narrative with the others brings into sharper relief a caveat that is duly acknowledged by advocates, but rarely illustrated: Western Governors is not for everyone.

Model of the Moment?

The nationwide push for college completion has two main parts. The first is getting high school students into, and through, postsecondary degree programs. The second is getting college degrees in the hands of adults who never earned one to begin with. That second group stands to become more important to completion goals as the proportion of high school graduates shrinks.

Research has shown that the most promising degree candidates in the second group are those with some college already under their belt. And these are Western Governors' specialty.

States have begun aggressively pursuing these errant learners. Texas, for example, has compiled a database of dropouts who have at least 100 hours' worth of college credit and instructed their alma maters to try to coax them back, says Ray Paredes, the state's commissioner of higher education.

Meanwhile, Texas -- whose governor recently challenged state institutions to come up with a four-year degree that would cost students less than $10,000 -- has been in talks with Western Governors about a potential WGU Texas, according to Paredes. (Some back-of-the-napkin arithmetic puts the cheapest Western Governors degree at a shade under $15,000 if completed in the average amount of time.)

"The whole issue of competency-based instruction … is all part of the national movement, that's gaining a lot of steam, to look at ways to deliver high-quality education at a reasonable price," says Paredes. "Because the model we currently have is unsustainable."

The model appears to be gaining momentum in some policy circles, even as the Obama administration, in its efforts to reduce fraud and abuse in federal financial aid programs, has taken steps to enshrine the traditional credit hour in federal law.

The Center for American Progress, meanwhile, has published several harsh critiques of the credit-hour as a standard for measuring progress toward a degree. “Policy efforts … that intentionally or unintentionally lock in the credit hour as the unit of measure based on seat time, for example, hold back the innovation in some significant ways to the detriment of students,” wrote the authors of one report published earlier this year.

“Policymakers must first address higher-education budget constraints by helping low-cost disruptive universities -- public and private -- gain market share by eliminating barriers and partnering with them to grow enrollments and capability,” says the report.

It goes on to laud Western Governors for marrying competency-based learning, which allows students to skip the stuff they already know, and online learning, which allows students to move at their own pace rather than the pace of their classmates and professors. The two innovations are, they say, a natural fit.

Meanwhile, the Center for Adult and Experiential Learning published a huge study last year that suggested students who were allowed to earn credit via "prior learning assessment" were far likelier to complete a degree. This was particularly true of Hispanic and black students. "Awarding college credit for significant life learning could be an effective way to accelerate degree completion, while lowering the cost, for underserved populations,” the center wrote in a follow-up research brief last month.

Even before the eggheads started weighing in, Western Governors -- whose early years, in the late 1990s, were plagued by accreditation woes and underwhelming growth -- had quietly begun to boom. Its enrollment, which stood at 500 students in 2003, has soared to 23,000. Between 2006 and last year, its yearly revenue shot from $32 million to $111 million.

Perfect pitch

The university’s recent shift to state-by-state colonization could mean even quicker growth. In the year since Daniels, the Indiana governor, announced the partnership with Western Governors, the number of Indiana residents enrolled at the online university has leaped from 300 to 1,200 -- more than 20 times the growth rate of the entire student body.

“The strategy is not only to be a state resource, but also to spread the model,” Mendenhall, the Western Governors president, told *Inside Higher Ed* in February. “So a state might choose to say, ‘OK, we’re going to create our own technology-based, competency-based university using the WGU model.’ I don’t know that states have the resources to do that right now. A faster, cheaper way for them to get to the same end would be essentially to private-label WGU and let us run it for them.”

Mendenhall knows that state governors are under pressure to increase college access and completion while slashing college budgets, and has tailored his sales pitch accordingly. He gave *Inside Higher Ed* a brief demo:

“Look, two-thirds of your jobs are going to require a college degree by 2013 [according to an oft-cited Georgetown University study], and 40 percent of your adults have a degree,” says Mendenhall, speaking as he would to state officials. “…You’re not going to get to 66 percent of your workforce having a postsecondary degree just by educating more people coming out of high school. You’ve got to go back and recover a lot of those adults. We fill a hole in your system that allows you to reach working adults and educate them for the jobs of the future -- and we’ll do it at no cost to the state.”

So far in Indiana, the move has been a strategic boon for both the governor and Western Governors. Daniels got kudos for showing a forward-thinking approach to meeting Indiana’s college completion goals without spending a dime on infrastructure: “All in all, Western Governors University appears to be a good fit for a Midwestern state with lots of busy, cash-strapped aspirants to higher education,” wrote *The Indianapolis Star*

in an editorial. (The Washington deal also garnered praise from the area's most influential newspaper: "Bringing this vision to Washington state will be a plus for our economy and citizens," read *The Seattle Times*.)

Western Governors, meanwhile, got a lot of free publicity, including a television ad featuring Daniels himself. The deal also opened the door to conversations with other state governments. Mendenhall said in February that Western Governors officials have been in talks with about a half-dozen other states, including several in the east. "Over the next five years we'll aim to do 10, 12 states and then see where that takes us," he says.

'Not a College Education'

But while the arrangements have worked out well for state politicians and Western Governors administrators, some educators in Indiana and Washington say such partnerships are unnecessary and inappropriate.

In an op-ed published in *The Seattle Times* shortly before the WGU Washington bill became law, Johann Neem, an associate professor of history at Western Washington University, wrote that the competency model "threatens what makes our system successful."

"A college education is about going through a process that leaves students transformed," Neem wrote. "That's why it takes time. Learning is hard -- brain research demonstrates that real learning requires students to struggle with difficult material under the consistent guidance of good teachers. WGU denies students these opportunities. In fact, its advertisements pander to prospective students by offering them credit for what they already know rather than promising to teach them something new.… Whatever WGU is, it is not a college education."

Neem was not alone. Because Washington created its locally branded version of WGU by legislative means, rather than by gubernatorial fiat, it invited a counter-lobbying effort in the run-up to the partnership. Professors at state institutions came out of the woodwork to object, says State Sen. Jim Kastama, who championed the bill.

"Behind the scenes, it was a difficult bill to get through," says Kastama. Some people tried in vain to block Western Governors from ever being eligible to collect in-state aid from Washington students, he says, but the law creating WGU Washington permits it to cash tuition checks paid with those in-state grants and scholarships, pending a review by the Higher Education Coordinating Board. Kastama says he does not expect that to be an obstacle.

Some academic leaders in Indiana, meanwhile, were miffed that the governor did not give them a chance to weigh in before partnering with Western Governors.

"What disappointed me beyond understanding was that the state would put resources into another program at the same time as they are cutting resources to every other nursing program in the state," says Marion Broome, dean of the school of nursing at Indiana University.

Jerry Pattengale, an associate provost at Indiana Wesleyan University, an independent nonprofit institution with a significant online presence, wrote in an e-mail that while he is a big fan of Governor Daniels, "There's an uneasy tension between the new federal regulations on credit integrity and the competency-based WGU approach." (Pattengale allows that "if the WGU approach is indeed valid, and legitimately sidesteps the extreme federal accrediting logistics, then Mitch is brilliant and over 60 Indiana campuses need to make a radical shift and follow suit.")

Anointing Western Governors as the state's "eighth public university" also raises questions about to what extent WGU Indiana is beholden to the same standards of curricular scrutiny as the other seven, Pattengale says.

Many existing public institutions offer flexible, online degree programs for adult learners. And most institutions also still count credits those adults earned long ago. In many cases, returning students would not have to log redundant credit hours if they want to finish their degrees.

"It was cast as if people suddenly had an opportunity to get a degree in a convenient manner, which simply wasn't true," says Pattengale, whose own institution, Indiana Wesleyan, owes a great deal of its recent growth to such programs.

A Red Herring?

Advocates of the state partnership model have dismissed such criticisms as petty and territorial. Of course public and other nonprofit institutions would be put off by Western Governors swooping in and snatching up students and their state-sponsored aid, they say -- the existing institutions want those students and tuition dollars for themselves.

But other critics say competition has nothing to do with it. They say the addition of Western Governors to the state university system could do more to distract from the problems of capacity and access than to solve them.

The Washington State public higher ed system currently struggles to accommodate traditional-age students, says Marsha Riddle Buly, professor of elementary education at Western Washington University. Each year, Washington's public institutions turn away many qualified high school graduates, Buly says. What the state needs to do is increase capacity in programs aimed at those students, she says.

"Those kids are going to have trouble succeeding in a program that is designed for older, working adults, who already have education and work experience," says Buly. "… WGU is not going to help get an 18-year-old freshman or a 20-year-old community college student to really do well and get a degree."

The graduation rate for first-time, full-time students at Western Governors is 22 percent, according to the most recent Education Department data.

The addition of Western Governors to the roster of state-endorsed universities could be insidious, not because the online university is illegitimate, but because it pays lip service to the capacity and access issues without doing much to fix them, says Karen Stout, an associate professor of communication and the incoming faculty senate president at Western Washington.

"It really doesn't improve the access issues," Stout says. "It's an illusion of access. If we want to provide more access for students and really address the needs of high school graduates … we need to expand access at the universities that they want to go to. And they're not seeking out WGU."

More likely, WGU Washington will attract community college students looking to upgrade to a baccalaureate program, who might have otherwise enrolled at a for-profit institution like University of Phoenix or Kaplan University, says Cable Green, the former director of e-learning for the Washington System of Community and Technical Colleges. For-profit institutions, which in recent years have fallen under intense scrutiny from federal watchdogs, tend to graduate students at similar rates and with more debt than Western Governors, which is nonprofit. And Mendenhall points out that while his university's 5 percent student loan default rate is higher than the rate at most public universities, it is substantially lower than at for-profit institutions.

Kastama, the state senator who led the effort to create WGU Washington, says he has no illusions that Western Governors will solve all his state's problems. "No, it's not the cat's meow," Kastama says. And true, the online, competency-based Western Governors University does represent "uncharted territory" in the constellation of state-backed higher education models.

But budget cutbacks are forcing state universities to raise tuition by more than 15 percent next year, with further hikes likely to come, Kastama says. In other words, new state investments in instructors, classrooms, and online infrastructure that some educators see as the key to addressing the capacity and access issues that would confound completion goals are not coming any time soon. In such times, Kastama says, what harm is there in publicizing alternatives?

For the latest technology news and opinion from Inside Higher Ed, follow @IHEtech on Twitter.

— Steve Kolowich

http://www.insidehighered.com/news/2011/05/09/western_governors_university_and_online_competency_based_learning_model_gain_traction

Translating 'Grad Student' Into English

May 13, 2011

Several years working on a Ph.D. in the back corner of a chemistry lab or lost in a library's stacks can make anyone a little detached from reality. So it's not surprising that when graduate students emerge from their years of close study on a topic, their dissertation titles can be a little unwieldy to the average graduation attendee or website visitor.

Paging through the 2011 graduation guide at Emory, one encounters the following dissertation titles:

- "Suppression of Calcineurin Signaling and PGC-1α Expression During the Chronic Skeletal Muscle Atrophy Associated with Diabetes Mellitus: Implications for Muscle Function."
- "Statistical Methods for Robust Estimation of Differential Protein Expression."
- "Hearing What You Expect to Hear: Investigating the Social and Cognitive Mechanisms Underlying Vocal Accommodation."

While those are valuable undertakings, and significant enough to earn Ph.D.'s from a research university, they're all a little unwieldy to the untrained eye.

So in 2010 the university's marketing and public relations department intervened. The office asked Ph.D. recipients to boil down their dissertations to about 100 words that summarized their research and explained its impact, all in a way that "a friend who wasn't in their field" could understand.

"We wanted to show how that knowledge generation has an impact on the world," said Jan Gleason, executive director of university marketing. "This isn't some esoteric work. These students' dissertations have applications and can inform other ideas."

So history Ph.D. Leah Weinryb Grohsgal's "Reinventing Civil Liberties: Religious Groups, Organized Litigation, and the Rights Revolution" becomes an exploration of how Jehovah's Witnesses helped spark the modern civil rights movement and shows that "religious liberty, far from being an afterthought, was integral to the 20th century transformation of civil rights." Psychology Ph.D. Pavel Blagov's "Personality Constellations in Incarcerated Men Who Scored High on Psychopathy" highlights two subcategories of "psychopaths" that could help prevent, diagnose, treat and rehabilitate such individuals.

In 2010, the university had 14 of its about 250 Ph.D. recipients explain their research in the humanities, natural and social sciences, and professions. This year, 24 of Emory's 225 Ph.D. recipients participated.

The exercise is certainly difficult. Not only does it require boiling down years of research, it also requires the student to step out of his or her discipline for a minute and try to relate to others. A look down the list shows that most can't quite eliminate all the complexity from their descriptions. There are still some big words and terms in each "translation" that laymen likely wouldn't understand, such as "Enantioselectively" and "Taylor rule fundamentals." But the descriptions are certainly less complex than the list of dissertation titles.

Some students took to the exercise naturally. Jongwoon "Willy" Choi, whose business dissertation explored the effects of signing bonuses, and the labor market they are made in, on worker motivation, said he is constantly trying to explain his research to those outside his field. He titled his dissertation "When Are Signing Bonuses More Than Just 'Pay to Play'? An Experimental Investigation." He said if his wife, mother, and sister can't understand what he's working on, he needs to rethink how he's describing it.

"In a field like business, it's important to get people to understand that the work academics do has a lot of applications to real-world business settings," he said. "We're exploring why we do these prevalent business practices, what might be wrong, and how things can be done better."

Choi, who's taking a job at the University of Pittsburgh's Katz School of Business next year, said he encourages all academics to think of an "elevator speech" about their research.

But the task wasn't so easy for all students. Some deal with abstract concepts or very specific scientific processes. Alyssa Dunn, a Ph.D. recipient in Emory's education school who "studied the recruitment and pedagogy of international teachers hired for U.S. urban schools and the policy context in which such recruitment unfolds," was one student who struggled to meet the marketing office's criteria.

Her problem was not converting her language to something that was comprehensible to readers: she has the kinds of findings that yearn to be made public, and because the findings are concrete examples of the problems that such programs create for students and teachers, the language doesn't deal with abstract theories or statistics.

Her problem was boiling down her 250-page dissertation of diverse findings into a 100-word statement. Because it was a case study instead of an exploration of a single hypothesis, there were multiple topics to discuss. "With so many different findings, you really have to think about which are most important now," she said. "What do people need to know about?"

Emory's dissertation project falls amid a bigger push nationwide to encourage researchers – particularly scientists – to become better communicators and develop the skills necessary to share their findings with the public.

The university engages in several other techniques to help graduate and undergraduate students, as well as professors, learn how to communicate research goals and findings. David Lynn, chairman of the chemistry department, runs a class where graduate students teach their research findings to freshmen and seniors.

Researchers at the university have even explored alternative forms of communication, such as pairing with artists, to reach even broader audiences. One program teamed science researchers with the Atlanta-based Out of Hand Theater. Together they designed a flash mob to help people understand molecular behavior.

"We're living in a world where, in all areas, information is changing so quickly," Lynn said. "When things change so quickly, people become fearful and recalcitrant. We need be able to share new information to make justifiable decisions, or as a community we can't go forward."

— Kevin Kiley

http://www.insidehighered.com/news/2011/05/13/emory_marketing_department_asks_phd_students_to_explain_dissertations_for_a_mass_audience

Fixing Accreditation, From the Inside

May 13, 2011

The higher education establishment has heard it from all sides in recent years -- from friend and foe, and from inside and outside of the walls of academe. The essential message: Fix the accreditation system that is the main gatekeeper for colleges to gain access to federal financial aid funds, or someone (read: government) will do it for you.

"The challenge for schools is to convince Congress ... and the administration that the conversation [about rethinking the system of quality control] is ongoing and that there are results from that conversation," a senior aide to Sen. Lamar Alexander told a higher education group three years ago, saying college leaders had a "five-year window" in which to work.

"The existing accreditation system has neither ensured quality nor ferreted out fraud," Anne Neal, president of the American Council of Trustees and Alumni and a frequent accreditation critic, wrote on *Inside Higher Ed* last year. "If Congress truly wants to protect the public interest, it needs to create a system that ensures real accountability."

"National and regional accreditors' ability to judge quality is under the microscope.... [W]e cannot lay low and hope that the glare of the spotlight will eventually fall on others," Molly Corbett Broad, president of the American Council on Education, said in a speech last spring to a regional accrediting body. "If we fail to act, it is likely that change will be imposed upon us, with potentially serious consequences for the governance structure that has allowed the United States to develop the best, most inclusive" higher education system in the world.

The scrutiny of accreditation has only increased since then. Leaders of Senate Democrats' harsh critique of for-profit higher education have implicated accreditors as flawed overseers if not enablers. And the Obama administration has asked its federal advisory panel on accreditation for ideas about how to reconfigure the current regulatory system to strengthen both quality assurance and consumer protection, possibly toward proposals that could be put into legislative form when the Higher Education Act, the main federal law governing college programs, is next reviewed in 2013.

So with all of that potential danger lurking, what to do -- and who should do it? The cynical answer might be to do what higher education leaders typically do: create a committee. That is indeed what Broad and the American Council on Education have done, creating the National Task Force on Institutional Accreditation, a panel of college presidents, accrediting agency heads and others that will hold its first meeting this month.

Easy as it might be to be cynical, creating a committee -- with a wide range of voices from a wide range of perspectives -- is the only logical way to attack a problem as complex and important as trying to fix accreditation, said Broad.

"We were trying to be sure we could get our arms around all the key people who have important and legitimate roles to play in this," she explained. The group includes not just a collection of presidents and chancellors of all types of colleges -- public and private, nonprofit and for-profit, two-year and four-year -- but accrediting agency officials, experts on accreditation, and one faculty leader, among others. The panel will also solicit and receive advice from outside analysts and experts. The focus is very much on regional accreditation of institutions, rather than accreditation of programs.

Given the vexing issues the panel plans to discuss -- concerns about the expanding sums of federal financial aid, the quality and extent of student learning, the rigor of state and federal consumer protection, and the

many new business models for higher education providers -- finding solutions is "going to be a very tough assignment," Broad conceded. Her hope is that the panel produces a "report with wide support and actionable recommendations" within 18 months.

And the price of failure? "Accreditation as we have known it has both helped to bring about the diversity that has been a hallmark of American higher education, and a very important protector and buffer for our institutions from inappropriate government regulation and legislation," Broad said, emphasizing that she believes some government regulation is wholly appropriate.

"If we fail to step up to addressing reforms, then I think it is virtually inevitable that in the interests of the larger public, we will see greater use of [government] regulations and legislation to impose reforms. The risk there is greatest because of the push toward standardization that inevitably occurs when you write regulations," she said.

"Our goal here," Broad added, "is to see how much of this reform we can reach agreement on and do by ourselves, and to ourselves."

The panel's members, in addition to Broad, are:

- Edward Ayers, president, University of Richmond (chair)
- Robert Berdahl, president, Association of American Universities (chair)
- Michael Brintnall, executive director, American Political Science Association
- Barbara Brittingham, president, New England Association of Schools & Colleges
- John Casteen III, president emeritus, University of Virginia
- Carol Christ, president, Smith College
- Dario Cortes, president, Berkeley College
- Judith Eaton, president, Council on Higher Education Accreditation
- Christopher Eisgruber, provost, Princeton University
- Rodney Erickson, executive vice president & provost, Pennsylvania State University
- Peter Ewell, vice president, National Center for Higher Education Management Systems
- Mary Fifield, president, Bunker Hill Community College
- Bobby Fong, president, Butler University
- Barbara Gitenstein, president, the College of New Jersey
- Frank Gornick, chancellor, West Hills Community College District
- Stanley Ikenberry, co-principal investigator, National Institute for Learning Outcomes Assessment
- Sylvia Manning, president, Higher Learning Commission, North Central Association of Colleges and Schools
- Patricia McGuire, president, Trinity University of D.C.
- Charlie Nelms, chancellor, North Carolina Central University
- George Pernsteiner, chancellor, Oregon University System
- Mohammad Qayoumi, president, California State University, East Bay
- Gary Rhoades, general secretary, American Association of University Professors
- Jerry Sue Thornton, president, Cuyahoga Community College
- Lesley Wilson, secretary general, European Universities Association
- Ralph Wolff, president, Western Association of Schools & Colleges (senior college commission)

— Doug Lederman

http://www.insidehighered.com/news/2011/05/13/higher_ed_group_creates_panel_to_weigh_new_future_for_accreditation

Mixed on Media

May 13, 2011

When Apple unveiled the iPad just over a year ago, publishers had high hopes that it would finally bump e-textbooks into the mainstream. But while the Apple iPad and computing tablet kin have made rapid gains on college campuses, printed textbooks are still alive and well thanks to a boom in rentals, according to a new survey from Student Monitor.

The survey, which polled 1,200 full-time students (average age: 20.6) at four-year institutions in March, found that the proportion of students who rented at least one textbook this spring doubled from last spring, leaping from 12 percent to 24 percent. Students who rented reported an average savings of $127. And the renting trend shows no sign of slowing: 36 percent of underclassmen said they are either likely or very likely to rent at least one textbook next semester.

The most popular rental source was campus bookstores, many of which made a big push to get out ahead of the rental trend by expanding (and publicizing) their rental operations prior to last fall. But students appeared to be most satisfied with their experiences with the independent book rental site Chegg.com, which they gave superior marks for price, punctuality, and ease of use.

E-textbooks, meanwhile, have continued to lag. Only 5 percent of the survey respondents said they purchased access to an e-textbook this spring. Two percent bought e-textbooks for more than one class. The most common reason for going electronic? “My professor required me to.”

Tablet computers, and especially the iPad, have nonetheless seized the cash and imaginations of students. As far as cachet, the Apple device is not quite as “in” as beer — but it is neck-in-neck with coffee, according to the survey, which polls students on a broad range of media and "lifestyle" tastes. More relevantly, the iPad is just as “in” (Student Monitor did not qualify the term) as laptops, even though 87 percent of respondents owned a laptop while just 8 percent owned an iPad. Nearly half reported being “interested in purchasing a wireless reading device,” with 70 percent of those students saying they had their eye on an iPad.

In fact, various forms of technology nearly swept the top trends on college campuses, with “drinking beer” the only non-tech interruption in a top 5 dominated by Facebook, iPhones, text messaging, and laptops. (“Working” and “going to grad school” were considered less “in” — though to the extent that the term might be interpreted as an observation of what is cool and/or new, that might not come as a surprise.)

Smartphones — i.e., iPhones, Androids, Blackberrys, and other devices that double as pocket-sized computers — also continue to proliferate on campuses. The gadgets, which are either soul-sapping attention vampires or revolutionary learning aids, depending on whom you ask, are now more than halfway to saturating the student market, according to the survey: 54 percent of students now own a smartphone, up from 41 percent at this time last year.While students tend to favor the online versions of national newspapers, they still like having their student newspaper in dead-tree form. If forced to choose between the two media, 38 percent said they would pick newsprint, while just 13 percent would opt for Web-only. And while three-quarters of students said their campus newspaper was available online, less than a fifth said they had read the Web version in the past month.

For the latest technology news and opinion from Inside Higher Ed, follow @IHEtech on Twitter.

— Steve Kolowich

http://www.insidehighered.com/news/2011/05/13/new_survey_on_student_technology_preferences

Revision and Patience

May 13, 2011
By Mark Longaker

I've taught high-school and college writing for nearly 15 years now. And I've directed a university writing program for three. In that time, I've found countless risible examples of student writing. I try not to share these. But temptation occasionally gets the better of me.

Here's a gem from this past semester. A student in a required first-year course recently sought to explain what he had learned. (I require such a written explanation at the end of the semester.) He wanted to show that he grasped something about "presentation," a category including grammatical correctness and stylistic felicity. So he wrote: "My improvement in presentation has improves also, I've gone from writing long and confusing sentences, to writing more clear and readable ones."

This is like hearing a cologne-soaked man intone: "We should talk more about how I've stopped philandering, perhaps over a drink at my apartment." Nevertheless, I'd like for you to consider something. Something that I had to remember myself. Writing is different from casual romance in a very important regard: the writer gets to revise. And the revision erases the first performance altogether. Would that all were so.

Perhaps, in some teaching practicum or graduate seminar, you were exposed to the glory of composition pedagogy, so you know the glittering magic of process and the transformative luster of revision. Those of us in rhetoric and writing delight in such terms, so we readily forget that others aren't so dazzled by their appearance. Allow me to illuminate.

The student mentioned above did write a poor sentence at an inopportune time. But I won't say that he learned nothing of grammar and style. Over the course of this semester, I watched as he wrote and revised several papers. The first drafts typically featured many sentences like the above. But subsequent drafts improved. As the class practiced editing techniques, as they learned a few choice grammar rules, I noticed that his ability to improve … well, improved. He got better at sentence-level revision. He learned to write concisely, clearly, and appropriately. Just not in the first draft.

By the way, the ability to revise for correctness and felicity improves all writing. It improves my writing. The second-to-last sentence in the paragraph above started out like this: "He really did learn to write clearer, more concise, and more readable prose." Then it became, "He did learn to write more clearly, more concisely, and more readably." Somewhere during the third iteration, I settled on a form but misspelled "learned": "leared."

Even the writing teacher needs a chance to rewrite.

Since my students submit their materials in electronic portfolios, I can revisit various stages of their work. I can see evidence to support this student's claim. His ultimately elegant expressions evolved from hideous, writhing syntactic monsters. Unfortunately, he did not have an opportunity to reconsider the sentence quoted above. While professing his ability to revise for style and grammar, he could not revise for style and grammar.

And so, this end-of-the semester self-evaluation that I require of my students is a cruel little puzzle with no satisfactory solution. This is like evaluating a professional dancer's merit based on an impromptu oration that describes his most recent and successful performance. Or evaluating an orator based on an interpretive dance version of her best speech. Perhaps the impropriety under investigation is not stylistic but pedagogical, not my student's but mine.

It's easy to chuckle at a single sentence, easy to focus on what's written and to overlook the writing. Good writing instruction, as you may have heard, requires attention to process and opportunity to revise. Or so a diligent, though not initially eloquent, student reminds me.

Mark Longaker is associate chair of the Department of Rhetoric and Writing at the University of Texas at Austin. He is grateful for his student's patience and permission to reprint the quote in this article.

http://www.insidehighered.com/views/2011/05/13/essay_on_reading_students_far_from_perfect_compositions

Beyond Tweets and Blogs

May 10, 2011
By Kevin Tynan

Attend a higher ed marketing conference or read a marketing blog these days and you'll quickly conclude that the path to recruitment, fund-raising and mission attainment is social media. Whatever the issue, a campaign built around (fill in the blank) tweets, blogs, LinkedIn, Facebook or whatever seems to be the key to achieving institutional goals.

Social media activists are invariably trotted out at conferences and webinars to demonstrate their recent excursion into the age of social media enlightenment.

Being the first one in the swimming pool, however, doesn't mean you're the strongest swimmer. It doesn't even mean you are much of a swimmer. It simply means you got wet first. Before we hurl ourselves headlong into the collective pool, we'd be advised to take a step or two back and look at social media from a broader perspective.

What is social media? It's a communication vehicle -- a way to reach and converse with others. It's not imbued with magical qualities to increase sales, raise money or feed the homeless. It's simply a tool that can help you achieve a goal -- much like a hammer is to a carpenter. In the hands of a skilled carpenter, it can be used to create a beautiful house. In lesser hands, you might end up with a dysfunctional garage.

As we know, when wielding a hammer everything is apt to look like a nail. That's what we're seeing in the current environment: early-bird practitioners urging us to rush out and put up blogs, launch LinkedIn campaigns, create digital publications, start podcasts and engage in all manner of activities that are part of the social media bandwagon.

What's wrong with that?

One big problem: a tool is not a strategy. A social media campaign does not equate with good marketing.

We can learn from the rush to execution that ensued when desktop publishing debuted in the '80s. With the purchase of PageMaker software, everyone suddenly became a graphic designer with the ability to produce ads, newsletters, logos and all manner of illustrations.

Obviously, managers and accountants didn't really become designers. They used the tools of a designer to execute some functions. Graphic design requires more than just pretty pictures. Judgment and creativity, quantitative and analytic thinking is the key to successfully conveying specific messages to targeted audiences. These skills don't come stuffed inside a software box. Graphic software may make the process easier, faster and less expensive but it's only valuable in the hands of skilled designer.

Currently, social media is about execution. I'm all for exploring sexy, fun new ways of reaching an audience, but social media evangelists seem to spend little time comparing their medium with alternatives that may be a better strategic fit or more cost-efficient. We rarely hear headliners caution that social media can be a worthless exercise, a drag on precious resources or damaging to reputations. There's little talk about limitations or failures or more reliable alternatives. It's as if everyone is whistling their way down the path and over the cliff drinking the collective Kool-Aid.

Examples of disastrous social media campaigns abound and they are not limited to cash-strapped nonprofits. Take a look at ThoughtPick's list of the top 10 social media campaign failures. It's littered with big brand

names from Wal-Mart and GM to Skittles and Starbucks -- huge retailers that had the resources for success and should have known better.

Last year Penn State University lost credibility with students and ignited a social media flameout when the university jousted with students and attempted to control critical comments on Facebook after the university refused to close the campus for a snow day. Students felt sufficiently abused to set up an alternative Facebook account to get their comments out and thereby blowing up the incident exponentially.

The University of North Carolina at Chapel Hill tightened Twitter rules after athletes' activities brought unwanted attention to their athletic program.

Regardless of size or good intentions, it's easy to make a social media mistake.

A focus on social media places a disproportionate emphasis on one component of the marketing mix: promotion. A 2011 survey of members pf the Council for Advancement and Support of Education found that 36 percent of higher education institutions had six or more full-time people assigned to social media. Ten percent had 20 or more.

This disproportionate emphasis leads practitioners to minimize or even overlook other components -- product, price and place -- key strategic considerations which are likely to be more important to ultimate success than social media. Before engaging in a social media campaign marketers should make sure the product is the best it can be, that consumer sentiment has helped shape it, that the price is appropriate for the marketplace and that we've made purchasing as easy and as convenient as possible. Each component in the marketing mix comes with a large body of work and research that should be seriously considered in any strategic marketing plan.

Ironically, Drake University's infamous D+ advertising campaign, which received national attention for associating the institution with a barely passing grade, could have been avoided if the university had first tested it through social media.

Social media is one communication tool within the promotional component. Other functions such as advertising, public relations, personal selling and sales promotion may complement or be better alternatives to social media. We can't increase bottom-line performance by ignoring other communication options.

Which brings me to some decidedly unsexy comments that you won't hear from convention headliners but will be helpful if you are considering a social media campaign.

1. Social media is in its embryonic stage. Internet Explorer is distributing version 12.0, but early versions were barely functional and didn't resemble today's browser. Read, learn, experiment as much as you like but don't place too many chips on the social media roulette wheel just yet. A few years ago headliners were urging clients to build campaigns around MySpace, which has tanked as an alternative to Facebook. The landscape is still in flux; products are trendy and largely untested.

2. Use a marketing plan to keep focused. Write a brief marketing plan before you start. Nothing elaborate, maybe one page. Identify the three key goals you are trying to achieve. Define the audience, your message and communication vehicles. Be critical. Ask yourself, Are there other, more cost-effective communication options that may more efficiently reach your audience? Sometimes a blog/Facebook page/SEO campaign is too slow/expensive/reaches the wrong demographic/sends the wrong message. Strategize first, execute second.

3. Rely on marketing principles -- not trendy ideas. Marketing principles are based on 70 years of research and practice. They are based on understanding consumer needs, wants and emotions. Fear, happiness, survival, love, jealousy, hunger are behavior motivators with a longer shelf life than a pair of Crocs. A good marketer will prod and survey, question and talk with the audience before creating the message and selecting the communication vehicles. We don't select the vehicle first (read: Twitter), then hope it reaches the right audience.

4. A good convention headliner pushes limits and stimulates creativity. But most headliners are no more marketing mavens than PageMaker users were graphic designers. They were simply first into the pool. A smart swimmer watches others, considers the depth, assesses his skills and then decides when and whether to get wet. Remember, convention headliners are generally entertaining and upbeat so anything that doesn't make the cut -- anything old school -- is edited out.

5. Get the facts behind the sizzle. Sure, putting an ad on a current events blog may give you street cred, but if you want to reach the typically affluent news junkie, for instance, try a newspaper. Recent Pew-funded research found that 95 percent of original news content on the Internet comes from legacy providers -- primarily newspapers. Gossip, opinion, speculation and hyperbole may attract readers but perhaps not those seeking authoritative, timely news.

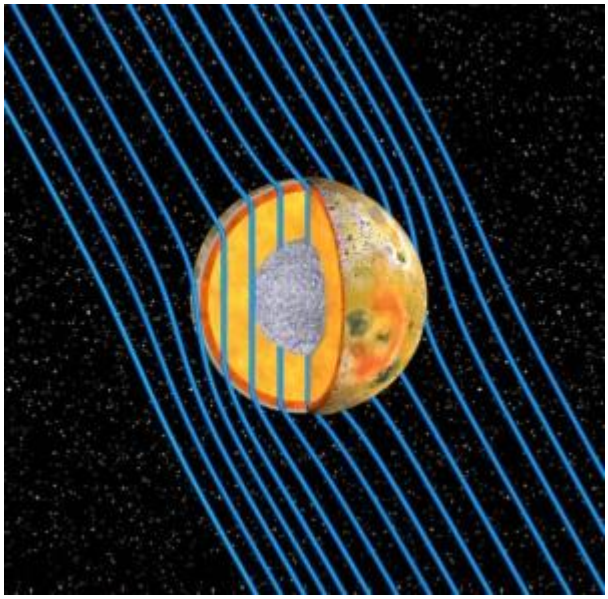
One blogger on Adrants.com recently wrote, "Agencies rightfully see social [media] as central to the future of marketing and work to develop in this space as fast as they can." Central to the future of marketing? That's the type of overblown hype we hear dispensed by headliners and pseudo-marketers. Sure, social media is an attractive communication vehicle but it's just that – a vehicle -- what about product, price, strategy, distribution, research and promotion? Shouldn't we focus on these key components before we select a communication vehicle?

And certainly agencies are working to develop the space as fast as they can; it's a money-making opportunity. But don't confuse the pronouncements of self-anointed, self-promoting social media experts with the need for a comprehensive marketing plan that's a little more thoughtful and takes little longer to plan and execute but has a better chance of taking you where you want to go.

Kevin Tynan is executive director for marketing and communications at the University of Illinois at Chicago. He is the author of Exposure! How to Market So Your Message is Unavoidable, Dartnell *and* Multi-Channel Marketing*.*

http://www.insidehighered.com/views/2011/05/10/essay_urging_colleges_to_be_cautious_about_social_media_strategies

NASA's Galileo Reveals Magma 'Ocean' Beneath Surface of Jupiter's Moon



This graphic shows the internal structure of Jupiter's moon Io as revealed by data from NASA's Galileo spacecraft. (Credit: NASA/JPL/University of Michigan/UCLA)

ScienceDaily (May 12, 2011) — A new analysis of data from NASA's Galileo spacecraft has revealed that beneath the surface of Jupiter's volcanic moon Io is an "ocean" of molten or partially molten magma.

The finding, from a study published May 13 in the journal *Science*, is the first direct confirmation of such a magma layer on Io and explains why the moon is the most volcanic object known in the solar system. The research was conducted by scientists from UCLA, UC Santa Cruz and the University of Michigan-Ann Arbor.

"The hot magma in Io's ocean is millions of times better at conducting electricity than rocks typically found on the Earth's surface," said the study's lead author, Krishan Khurana, a former co-investigator on Galileo's magnetometer team and a research geophysicist with UCLA's Institute of Geophysics and Planetary Physics. "Just like the waves beamed from an airport metal detector bounce off metallic coins in your pocket, betraying their presence to the detector, Jupiter's rotating magnetic field continually bounces off the molten rocks in Io's interior. The bounced signal can be detected by a magnetometer on a passing spacecraft.

"Scientists are excited that we finally understand where Io's magma is coming from and have an explanation for some of the mysterious signatures we saw in some of Galileo's magnetic field data," Khurana added. "It turns out Io was continually giving off a 'sounding signal' in Jupiter's rotating magnetic field that matched what would be expected from molten or partially molten rocks deep beneath the surface."

Io's volcanoes are the only known active magma volcanoes in the solar system other than those on Earth; Io produces about 100 times more lava each year than all of Earth's volcanoes. While those on Earth occur in localized hotspots like the "Ring of Fire" around the Pacific Ocean, Io's volcanoes are distributed all over its surface. A global magma ocean lying beneath about 20 to 30 miles (30 to 50 km) of Io's crust helps explain the moon's activity.

"It has been suggested that both the Earth and moon may have had similar magma oceans billions of years ago, at the time of their formation, but they have long since cooled," said Torrence Johnson, who was Galileo's project scientist, based at NASA's Jet Propulsion Laboratory in Pasadena, Calif., and who was not directly involved in the study. "Io's volcanism informs us how volcanoes work and provides a window in time to styles of volcanic activity that may have occurred on the Earth and moon during their earliest history."

Io's volcanoes were discovered by NASA's Voyager spacecraft in 1979. The energy for the volcanic activity comes from the squeezing and stretching of the moon by Jupiter's gravity as Io orbits the immense planet, the largest in the solar system.

Galileo was launched in 1989 and began orbiting Jupiter in 1995. After a successful mission, the spacecraft was intentionally sent into Jupiter's atmosphere in 2003. The unexplained signatures appeared in the magnetic-field data taken from Galileo fly-bys of Io in October 1999 and February 2000, during the final phase of the mission.

"But at the time, models of the interaction between Io and Jupiter's immense magnetic field, which bathes the moon in charged particles, were not yet sophisticated enough for us to understand what was going on in Io's interior," said study co-author Xianzhe Jia of the University of Michigan.

Recent work in mineral physics showed that a group of what are known as "ultramific" rocks become capable of carrying substantial electrical current when melted. These rocks are igneous in origin -- that is, they are formed through the cooling of magma. On Earth, ultramific rocks are believed to derive from the mantle. The finding led Khurana and colleagues to test the hypothesis that the strange signature was produced by an electrical current flowing in a molten or partially molten layer of this kind of rock.

Tests showed that the signatures detected by Galileo were consistent with a rock like lherzolite, an igneous rock rich in silicates of magnesium and iron found, for example, in Spitzbergen, Sweden. The magma ocean layer on Io appears to be more than 30 miles (50 km) thick, making up at least 10 percent of the moon's mantle by volume. The blistering temperature of the magma ocean probably exceeds 2,200 degrees Fahrenheit (1,200 degrees Celsius).

Additional co-authors on the paper are Christopher T. Russell, professor of geophysics and space physics in UCLA's Department of Earth and Space Sciences; Margaret Kivelson, professor emeritus of space physics in UCLA's Department of Earth and Space Sciences; Gerald Schubert, professor of geophysics and planetary physics in UCLA's Department of Earth and Space Sciences; and Francis Nimmo, associate professor of Earth and planetary sciences at UC Santa Cruz.

Additional information about the Galileo mission and its discoveries is available online at http://solarsystem.nasa.gov/galileo and www.jpl.nasa.gov/galileo-legacy.

The Galileo mission was managed by the Jet Propulsion Laboratory (JPL), a division of the California Institute of Technology in Pasadena, for NASA.

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 Jia-Rui Cook.

Journal Reference:

1. Krishan K. Khurana, Xianzhe Jia, Margaret G. Kivelson, Francis Nimmo, Gerald Schubert, Christopher T. Russell. **Evidence of a Global Magma Ocean in Io's Interior**. *Science*, 2011; DOI: 10.1126/science.1201425

http://www.sciencedaily.com/releases/2011/05/110512150723.htm

Whales Have Accents and Regional Dialects: Biologists Interpret the Language of Sperm Whales

Fingers and her baby Thumb swim together off the coast of Dominica. (Credit: Photo courtesy of Shane Gero)

ScienceDaily (May 12, 2011) — Dalhousie Ph.D. student Shane Gero has recently returned from a seven-week visit to Dominica. He has been traveling to the Caribbean island since 2005 to study families of sperm whales, usually spending two to four months of each year working on the Dominica Sperm Whale Project. One of the goals of this project is to record and compare whale calls over time, examining the various phrases and dialects of sperm whale communities.

When they dive together, sperm whales make patterns of clicks to each other known as "codas." Recent findings suggest that not only do different codas mean different things, but that whales can also tell which member of their community is speaking based on the sound properties of the codas. Just as we can tell our friends apart by the sounds of their voices and the way they pronounce their words, different sperm whales make the same pattern of clicks, but with different accents.

Caribbean and Pacific whales have different repertoires of codas, like a regional dialect, but the "Five Regular" call -- a pattern of five evenly spaced clicks -- is thought to have the universal function of individual identity because it is used by sperm whales worldwide.

These discoveries were recently published in the journal *Animal Behaviour*, in an article authored by University of St. Andrews PhD student Ricardo Antunes, Dal alumnus Tyler Schulz, Mr. Gero, Dal professor Dr. Hal Whitehead, and St. Andrews faculty members Dr. Jonathan Gordon and Dr. Luke Rendell.

Mr. Gero and Dr. Whitehead explain that the sperm whale's biggest threat is human pollution. Not only do humans introduce toxins into the ocean, but they also generate harmful sound pollution. Increased shipping traffic, underwater explosions caused by searching for oil, and military sonar all contribute to ocean noise that masks communication between whales. "No one wants to live in a rock concert," says Mr. Gero, adding that noise pollution is especially troublesome in the ocean because "it is a totally different sensory world." The sperm whales can dive to depths of over 1000 metres and depend on sound for communication and navigation in the pitch black of the deep water.

The Dominica Sperm Whale Project hopes to understand more about sperm whale society because, as Mr. Gero says, "it is infuriating that we know more about the moon than the oceans." He hopes to communicate a better understanding of life in the oceans to people by using these beautiful whales as examples, and by placing an emphasis on "how similar their lives actually are to ours."

The whales live in matriarchal social units composed of mothers, daughters, and grandmothers. Once males reach adolescence, they are ostracized from the group and travel towards the poles until they are ready to breed. Consequently, little is known about the males, but the roles of females in relation to their young have been studied extensively by Mr. Gero and Dr. Whitehead. Female whales will baby-sit each other's offspring while mothers are diving, forming a strong community that revolves around the upbringing of calves. "They are nomadic," explains Dr. Whitehead, "so the most important things in their lives are each other."

Dr. Whitehead enjoys researching sperm whales because of their "fascinating and complex social lives." He hopes the Dominica Sperm Whale Project will be able to trace how whale communities change through time. Part of Mr. Gero's PhD includes studying how calves acquire their dialect. Baby sperm whales babble at first, and Mr. Gero is interested in discovering how the babies' diversity of calls gets narrowed down to the family repertoire.

"One of the most exciting parts [of returning to Dominica] is to go down and see who's around," says Mr. Gero, admitting that he has "become attached to the individual whales." For the first time, sperm whales can be studied as individuals within families, with such lovable nicknames as "Pinchy" and "Fingers." The family that includes these two whales is recognized as "the best studied social unit of sperm whales in the world." Mr. Gero would like to continue working with the same groups of whales because a long-term project will offer a better understanding of their social developments. He "feels a responsibility to speak on [the whales'] behalf" and hopes to move toward conservation, while still remaining in the field of biology.
More information about the Dominica Sperm Whale Project can be found at:
http://whitelab.biology.dal.ca/dswp/

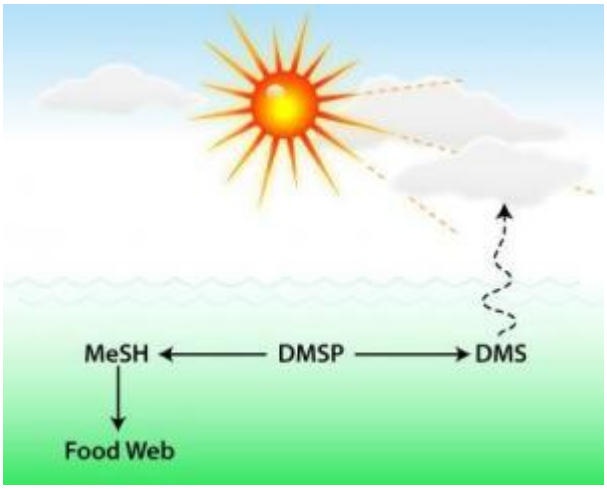
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Dalhousie University**.

Journal Reference:

1. Ricardo Antunes, Tyler Schulz, Shane Gero, Hal Whitehead, Jonathan Gordon, Luke Rendell. **Individually distinctive acoustic features in sperm whale codas**. *Animal Behaviour*, 2011; DOI: 10.1016/j.anbehav.2010.12.019

http://www.sciencedaily.com/releases/2011/05/110512104252.htm

Can Clouds Help Mitigate Global Warming? Missing Links Found in Biology of Cloud Formation Over Oceans



A simplified graphic shows the process by which bacterioplankton send sulfur found in decaying algae into the food web or into the atmosphere, where it leads to water droplet formation -- the basis of clouds that cool the Earth. (Credit: Chris Reisch, University of Georgia)

ScienceDaily (May 12, 2011) — Scientists have known for two decades that sulfur compounds that are produced by bacterioplankton as they consume decaying algae in the ocean cycle through two paths. In one, a sulfur compound dimethylsulfide, or DMS, goes into the atmosphere, where it leads to water droplet formation -- the basis of clouds that cool Earth. In the other, a sulfur compound goes into the ocean's food web, where it is eaten and returned to seawater.

What they haven't known is how sulfur is routed one way or the other or why.

They also have wondered what if -- in a time of growing concern about global warming -- it was possible to divert the sulfur compound that goes into the oceans into the atmosphere, helping to mitigate global warming?

A study by researchers at the University of Georgia just published in *Nature* brings the possibility of using the sulfur cycle to mitigate global warming closer with the identification of the steps in the biochemical pathway that controls how bacteria release the sulfur compound methanethiol, or MeSH, into the microbial food web in the oceans and the genes responsible for that process.

"With our increased understanding of the sulfur cycle in the ocean," said study co-author William (Barny) Whitman, "we are now better able to evaluate the impacts of climate change on the process and the potential for its manipulation, which has been proposed as a way to mitigate global warming.

"It's wonderful to have this much understanding of a major biogeochemical process," noted Whitman, distinguished research professor and head of the department of microbiology in the Franklin College of Arts and Sciences.

In addition to elucidating the steps in the pathway and identifying the responsible genes, the team of UGA microbiologists, marine scientists and chemists discovered that the pathway is found widely, not only among bacterioplankton in the ocean but also in non-marine environments.

"The big mystery about bacteria is what they are doing in nature," Whitman said. "The organisms metabolize compounds for their own needs. We need to understand what they are getting out of it to understand what it means for the ocean, and now it will be possible to look at the environmental importance of this process and how it's regulated." That will help to answer the "why" of the two sulfur fates.

Co-authors of the Nature paper were UGA graduate students Chris Reisch and Vanessa Varaljay, department of microbiology; graduate student Melissa Stoudemayer and Jon Amster, professor and head, department of chemistry; and distinguished research professor Mary Ann Moran, department of marine sciences -- all in the Franklin College of Arts and Sciences.

The collaborators in this study built on a line of research begun at UGA over a decade ago. Moran's early research showed that an abundant group of bacteria known as marine roseobacters play a role in moving

dimethylsulfonioproprionate (DMSP), the chemical made by marine algae and released into the water upon their death, into the atmosphere as the compound dimethylsulfide (DMS).
In 2006, Moran's research group discovered in marine bacteria the first step in the process of turning DMSP into MeSH, instead of sending sulfur into the atmosphere. And in 2008, Moran's doctoral student Erinn Howard, in collaboration with Whitman's lab, discovered the gene that allows marine roseobacters to keep sulfur in the ocean.
With funding from the National Science Foundation and the Gordon and Betty Moore Foundation, the UGA researchers have now identified the rest of the pathway, including identifying two previously unknown but related chemical compounds that serve as intermediates between MMPA, the first product of degraded DMSP, and MeSH, the final product.
The collaboration with UGA chemists using high-resolution mass spectrometry made it possible for the researchers to identify the compounds. A major surprise was the presence of Coenzyme A (CoA), a large molecule important in metabolism, in the intermediate compounds.
"We weren't really expecting CoA to be involved," said Reisch, who was part of the UGA group that five years ago identified the first step in the pathway that produces MeSH. "We thought they would be smaller fatty acids."
With the discovery of the intermediates, it was possible to find the enzymes that catalyzed the reaction and then the genes. And once the genes were discovered, the researchers were able to analyze databases of marine bacteria to determine which bacteria possess the genes capable of carrying out the MeSH process.
The group discovered that the MeSH pathway is widespread among bacterioplankton in the ocean. "The genes may be in up to 61 percent of surface ocean bacterioplankton," said Reisch, "while the DMS pathway is present in less than 5 percent of cells." However, he said, "There could be a lot more that we don't yet know about. Some bacteria, including the model bacteria used in the study, have both pathways."
But the researchers also found the genes for the MeSH pathway in bacteria from a variety of non-marine habitats, including bacteria commonly found in soils, plants, extreme environments and humans. They note in their Nature paper that the presence of the newly discovered pathway in diverse bacteria further emphasizes its importance.

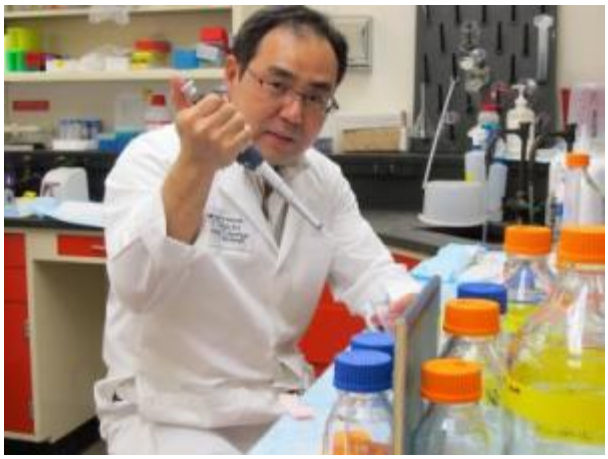
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of Georgia**. The original article was written by Terry Marie Hastings.

Journal Reference:

1. Chris R. Reisch, Melissa J. Stoudemayer, Vanessa A. Varaljay, I. Jonathan Amster, Mary Ann Moran, William B. Whitman. **Novel pathway for assimilation of dimethylsulphoniopropionate widespread in marine bacteria**. *Nature*, 2011; 473 (7346): 208 DOI: 10.1038/nature10078

http://www.sciencedaily.com/releases/2011/05/110511134209.htm

Why Some Genes Are Silenced: Researchers Find Clue as to How Notes Are Played on the 'Genetic Piano'



Dr. Kohzoh Mitsuya, of the School of Medicine at the University of Texas Health Science Center San Antonio, is co-author of a paper in Science pointing to an epigenetics rationale for why some genes are silenced and others are not. (Credit: UT Health Science Center San Antonio)

ScienceDaily (May 13, 2011) — Japanese and U.S. scientists in the young field of epigenetics have reported a rationale as to how specific genes are silenced and others are not. Because this effect can be reversed, it may be possible to devise therapies for cancer and other diseases using this information.

The *NOVA* U.S. public television program described epigenetics as "The Ghost In Your Genes." It is the study of changes in gene expression that occur without changes in DNA sequence. Like keys on a piano, DNA is the static blueprint for all the proteins that cells produce. Epigenetic information provides additional dynamic or flexible instructions as to how, where and when the blueprint will be used. "It corresponds to a pianist playing a piece of music," said Kohzoh Mitsuya, Ph.D., postdoctoral fellow in the School of Medicine at The University of Texas Health Science Center San Antonio.

Article in *Science*

The study by Dr. Mitsuya and colleagues is outlined in the May 13 issue of the journal *Science*. The team found that a small RNA pathway is required to establish an epigenetic modification -- called DNA methylation -- at a gene that codes for mammalian proteins. DNA methylation adds chemical tags called methyl groups to specific genes, usually silencing their expression.

"DNA methylation marks are reversible, so there is great interest in devising therapeutic strategies, for instance in cancer biology, to epigenetically reactivate silenced tumor-suppressor genes or inactivate specific oncogenes in human cancer cells," Dr. Mitsuya, the *Science* paper's third author, said. The lead author is Toshiaki Watanabe, Ph.D., of the National Institute of Genetics in Japan and Yale University.

Environment and cancer

Beyond being reversible, DNA methylation is susceptible to environmental influences. Many cancer biologists now agree that changes in DNA methylation might be as important as genetic mutations in causing cancer. There are far more epigenetic changes than genetic changes found in the majority of cancers, and research into epigenetics is proving to be important to understanding cancer biology.

"It is critical to identify the entire complement of factors that affect gene silencing," Dr. Mitsuya said. "This was the rationale behind this study examining DNA methylation in mice that I began in 2004. The study adds information about one set of factors."

A finger on the piano

The researchers compared a group of normal mice with a group lacking the small RNA species. The team found that DNA methylation was markedly reduced at one of four genes tested in the small RNA-deficient mice. "This is the first demonstration that small RNAs can act in this way," Dr. Mitsuya said. "It shows how one note is played on the piano."

Epigenetic activity is a previously unseen dimension of biology that may enable clearer detection of disease, monitoring of progression and improved treatment, and may provide entirely new biomarkers of disease

susceptibility. "The symphony has only just come into view," Dr. Mitsuya said. "We can hear it, but we need to learn how all the parts are being played."
Dr. Mitsuya is a member of the Center for Pregnancy and Newborn Research in the Department of Obstetrics and Gynecology, School of Medicine, at the UT Health Science Center San Antonio and is engaged in epigenetic studies of placental function.

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**.

Journal Reference:

1. T. Watanabe, S.-i. Tomizawa, K. Mitsuya, Y. Totoki, Y. Yamamoto, S. Kuramochi-Miyagawa, N. Iida, Y. Hoki, P. J. Murphy, A. Toyoda, K. Gotoh, H. Hiura, T. Arima, A. Fujiyama, T. Sado, T. Shibata, T. Nakano, H. Lin, K. Ichiyanagi, P. D. Soloway, H. Sasaki. **Role for piRNAs and Noncoding RNA in de Novo DNA Methylation of the Imprinted Mouse Rasgrf1 Locus**. *Science*, 2011; 332 (6031): 848 DOI: 10.1126/science.1203919

http://www.sciencedaily.com/releases/2011/05/110512150719.htm

On Prehistoric Supercontinent of Pangaea, Latitude and Rain Dictated Where Species Lived

Reptile precursor. The skull of the procolophonid Hypsognathus was found in Fundy basin, Nova Scotia, which was hotter and drier when it was part of Pangaea. Mammals, needing more water, chose to live elsewhere. (Credit: Image courtesy of Brown University)

ScienceDaily (May 13, 2011) — More than 200 million years ago, mammals and reptiles lived in their own separate worlds on the supercontinent Pangaea, despite little geographical incentive to do so. Mammals lived in areas of twice-yearly seasonal rainfall; reptiles stayed in areas where rains came just once a year. Mammals lose more water when they excrete, and thus need water-rich environments to survive. Results are published in the *Proceedings of the National Academy of Sciences.*

Aggregating nearly the entire landmass of Earth, Pangaea was a continent the likes our planet has not seen for the last 200 million years. Its size meant there was a lot of space for animals to roam, for there were few geographical barriers, such as mountains or ice caps, to contain them.

Yet, strangely, animals confined themselves. Studying a transect of Pangaea stretching from about three degrees south to 26 degrees north (a long swath in the center of the continent covering tropical and semiarid temperate zones), a team of scientists led by Jessica Whiteside at Brown University has determined that reptiles, represented by a species called procolophonids, lived in one area, while mammals, represented by a precursor species called traversodont cynodonts, lived in another. Though similar in many ways, their paths evidently did not cross.

"We're answering a question that goes back to Darwin's time," said Whiteside, assistant professor of geological sciences at Brown, who studies ancient climates. "What controls where organisms live? The two main constraints are geography and climate."

Turning to climate, the frequency of rainfall along lines of latitude directly influenced where animals lived, the scientists write in a paper published this week in the online early edition of the *Proceedings of the National Academy of Sciences*. In the tropical zone where the mammal-relative traversodont cynodonts lived, monsoon-like rains fell twice a year. But farther north on Pangaea, in the temperate regions where the procolophonids predominated, major rains occurred only once a year. It was the difference in the precipitation, the researchers conclude, that sorted the mammals' range from that of the reptiles.

On Pangaea, the mammals needed a water-rich area, so the availability of water played a decisive role in determining where they lived. "It's interesting that something as basic as how the body deals with waste can restrict the movement of an entire group," Whiteside said.

In water-limited areas, "the reptiles had a competitive advantage over mammals," Whiteside said. She thinks the reptiles didn't migrate into the equatorial regions because they already had found their niche.

The researchers compiled a climate record for Pangaea during the late Triassic period, from 234 million years ago to 209 million years ago, using samples collected from lakes and ancient rift basins stretching from modern-day Georgia to Nova Scotia. Pangaea was a hothouse then: Temperatures were about 20 degrees Celsius hotter in the summer, and atmospheric carbon dioxide was five to 20 times greater than today. Yet there were regional differences, including rainfall amounts.

The researchers base the rainfall gap on variations in Earth's precession, or the wobble on its axis, coupled with the eccentricity cycle, based on Earth's orbital position to the sun. Together, these Milankovitch cycles

influence how much sunlight, or energy, reaches different areas of the planet. During the late Triassic, the equatorial regions received more sunlight, thus more energy to generate more frequent rainfall. The higher latitudes, with less total sunlight, experienced less rain.
The research is important because climate change projections shows areas that would receive less precipitation, which could put mammals there under stress.
"There is evidence that climate change over the last 100 years has already changed the distribution of mammal species," said Danielle Grogan, a graduate student in Whiteside's research group. "Our study can help us predict negative climate effects on mammals in the future."
Contributing authors include Grogan, Paul Olsen from Columbia University, and Dennis Kent from Rutgers.
The National Science Foundation and the Richard Salomon 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. Jessica H. Whiteside, Danielle S. Grogan, Paul E. Olsen, Dennis V. Kent. **Climatically driven biogeographic provinces of Late Triassic tropical Pangea**. *Proceedings of the National Academy of Sciences*, 2011; DOI: 10.1073/pnas.1102473108

http://www.sciencedaily.com/releases/2011/05/110512150823.htm

Strong, Tough and Now Cheap: New Way to Process Metallic Glass Developed

A metallic-glass rod before heating and molding (left); a molded metallic-glass part (middle); the final product with its excess material trimmed off (right). (Credit: Marios D. Demetriou)

ScienceDaily (May 13, 2011) — Stronger than steel or titanium -- and just as tough -- metallic glass is an ideal material for everything from cell-phone cases to aircraft parts. Now, researchers at the California Institute of Technology (Caltech) have developed a new technique that allows them to make metallic-glass parts utilizing the same inexpensive processes used to produce plastic parts. With this new method, they can heat a piece of metallic glass at a rate of a million degrees per second and then mold it into any shape in just a few milliseconds.

"We've redefined how you process metals," says William Johnson, the Ruben F. and Donna Mettler Professor of Engineering and Applied Science. "This is a paradigm shift in metallurgy." Johnson leads a team of researchers who are publishing their findings in the May 13 issue of the journal *Science*.

"We've taken the economics of plastic manufacturing and applied it to a metal with superior engineering properties," he says. "We end up with inexpensive, high-performance, precision net-shape parts made in the same way plastic parts are made -- but made of a metal that's 20 times stronger and stiffer than plastic." A net-shape part is a part that has acquired its final shape.

Metallic glasses, which were first discovered at Caltech in 1960 and later produced in bulk form by Johnson's group in the early 1990s, are not transparent like window glass. Rather, they are metals with the disordered atomic structure of glass. While common glasses are generally strong, hard, and resistant to permanent deformation, they tend to easily crack or shatter. Metals tend to be tough materials that resist cracking and brittle fracture -- but they have limited strength. Metallic glasses, Johnson says, have an exceptional combination of both the strength associated with glass and the toughness of metals.

To make useful parts from a metallic glass, you need to heat the material until it reaches its glass-transition phase, at about 500-600 degrees C. The material softens and becomes a thick liquid that can be molded and shaped. In this liquid state, the atoms tend to spontaneously arrange themselves to form crystals. Solid glass is formed when the molten material refreezes into place before its atoms have had enough time to form crystals. By avoiding crystallization, the material keeps its amorphous structure, which is what makes it strong. Common window glass and certain plastics take from minutes to hours -- or longer -- to crystallize in this molten state, providing ample time for them to be molded, shaped, cooled, and solidified. Metallic glasses, however, crystallize almost immediately once they are heated to the thick-liquid state. Avoiding this rapid crystallization is the main challenge in making metallic-glass parts.

Previously, metallic-glass parts were produced by heating the metal alloy above the melting point of the crystalline phase -- typically over 1,000 degrees C. Then, the molten metal is cast into a steel mold, where it cools before crystallizing. But problems arise because the steel molds are usually designed to withstand temperatures of only around 600 degrees C. As a result, the molds have to be frequently replaced, making the process rather expensive. Furthermore, at 1,000 degrees C, the liquid is so fluid that it tends to splash and break up, creating parts with flow defects.

If the solid metallic glass is heated to about 500-600 degrees C, it reaches the same fluidity that liquid plastic needs to have when it's processed. But it takes time for heat to spread through a metallic glass, and by the time the material reaches the proper temperature throughout, it has already crystallized.
So the researchers tried a new strategy: to heat and process the metallic glass extremely quickly. Johnson's team discovered that, if they were fast enough, they could heat the metallic glass to a liquid state that's fluid enough to be injected into a mold and allowed to freeze -- all before it could crystallize.
To heat the material uniformly and rapidly, they used a technique called ohmic heating. The researchers fired a short and intense pulse of electrical current to deliver an energy surpassing 1,000 joules in about 1 millisecond -- about one megawatt of power -- to heat a small rod of the metallic glass.
The current pulse heats the entire rod -- which was 4 millimeters in diameter and 2 centimeters long -- at a rate of a million degrees per second. "We uniformly heat the glass at least a thousand times faster than anyone has before," Johnson says. Taking only about half a millisecond to reach the right temperature, the now-softened glass could be injected into a mold and cooled -- all in milliseconds. To demonstrate the new method, the researchers heated a metallic-glass rod to about 550 degrees C and then shaped it into a toroid in less than 40 milliseconds. Despite being formed in open air, the molded toroid is free of flow defects and oxidation.
In addition, this process allows researchers to study these materials in their molten states, which was never before possible. For example, by heating the material before it can crystallize, researchers can examine the crystallization process itself on millisecond time scales. The new technique, called rapid discharge forming, has been patented and is being developed for commercialization, Johnson says. In 2010, he and his colleagues started a company, Glassimetal Technology, to commercialize novel metallic-glass alloys using this kind of plastic-forming technology.
The other authors on the *Science* paper, "Beating crystallization in glass-forming metals by millisecond heating and processing," are Caltech's Georg Kaltenboeck, Marios D. Demetriou, Joseph P. Schramm, Xiao Liu, Konrad Samwer (a visiting associate from the University of Gottingen, Germany), C. Paul Kim, and Douglas C. Hofmann. This research benefited from support by the II-VI Foundation.

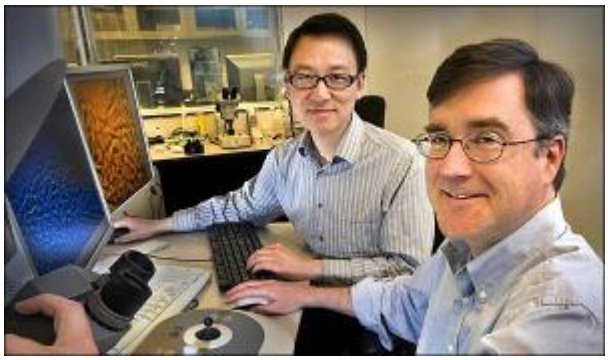
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **California Institute of Technology**. The original article was written by Marcus Woo.

Journal Reference:

1. W. L. Johnson, G. Kaltenboeck, M. D. Demetriou, J. P. Schramm, X. Liu, K. Samwer, C. P. Kim, D. C. Hofmann. **Beating Crystallization in Glass-Forming Metals by Millisecond Heating and Processing**. *Science*, 2011; 332 (6031): 828 DOI: 10.1126/science.1201362

http://www.sciencedaily.com/releases/2011/05/110512150815.htm

Super Energy Storage: Activated Graphene Makes Superior Supercapacitors for Energy Storage



Dong Su and Eric Stach use a powerful electron microscope to analyze samples of activated graphene at Brookhaven's Center for Functional Nanomaterials. Says Stach: "The CFN provides access to scientists around the world to solve cutting-edge problems in nanoscience and nanotechnology. This work is exactly what this facility was established to do." (Credit: Image courtesy of DOE/Brookhaven National Laboratory)

ScienceDaily (May 13, 2011) — Scientists at the U.S. Department of Energy's Brookhaven National Laboratory have helped to uncover the nanoscale structure of a novel form of carbon, contributing to an explanation of why this new material acts like a super-absorbent sponge when it comes to soaking up electric charge. The material, which was recently created at The University of Texas -- Austin, can be incorporated into "supercapacitor" energy-storage devices with remarkably high storage capacity while retaining other attractive attributes such as superfast energy release, quick recharge time, and a lifetime of at least 10,000 charge/discharge cycles.

"Those properties make this new form of carbon particularly attractive for meeting electrical energy storage needs that also require a quick release of energy -- for instance, in electric vehicles or to smooth out power availability from intermittent energy sources, such as wind and solar power," said Brookhaven materials scientist Eric Stach, a co-author on a paper describing the material published in *Science* on May 12, 2011.

Supercapacitors are similar to batteries in that both store electric charge. Batteries do so through chemical reactions between metallic electrodes and a liquid electrolyte. Because these chemicals take time to react, energy is stored and released relatively slowly. But batteries can store a lot of energy and release it over a fairly long time.

Supercapacitors, on the other hand, store charge in the form of ions on the surface of the electrodes, similar to static electricity, rather than relying on chemical reactions. Charging the electrodes causes ions in the electrolyte to separate, or polarize, as well -- so charge gets stored at the interface between the electrodes and the electrolyte. Pores in the electrode increase the surface area over which the electrolyte can flow and interact -- increasing the amount of energy that can be stored.

But because most supercapacitors can't hold nearly as much charge as batteries, their use has been limited to applications where smaller amounts of energy are needed quickly, or where long life cycle is essential, such as in mobile electronic devices.

The new material developed by the UT-Austin researchers may change that. Supercapacitors made from it have an energy-storage capacity, or energy density, that is approaching the energy density of lead-acid batteries, while retaining the high power density -- that is, rapid energy release -- that is characteristic of supercapacitors.

"This new material combines the attributes of both electrical storage systems," said University of Texas team leader Rodney Ruoff. "We were rather stunned by its exceptional performance."

The UT-Austin team had set out to create a more porous form of carbon by using potassium hydroxide to restructure chemically modified graphene platelets -- a form of carbon where the atoms are arrayed in tile-like rings laying flat to form single-atom-thick sheets. Such "chemical activation" has been previously used to create various forms of "activated carbon," which have pores that increase surface area and are used in filters and other applications, including supercapacitors.

But because this new form of carbon was so superior to others used in supercapacitors, the UT-Austin researchers knew they'd need to characterize its structure at the nanoscale.

Ruoff had formed a hypothesis that the material consisted of a continuous three-dimensional porous network with single-atom-thick walls, with a significant fraction being "negative curvature carbon," similar to inside-out buckyballs. He turned to Stach at Brookhaven for help with further structural characterization to verify or refute this hypothesis.

Stach and Brookhaven colleague Dong Su conducted a wide range of studies at the Lab's Center for Functional Nanomaterials, the National Synchrotron Light Source, and at the National Center for Electron Microscopy at Lawrence Berkeley National Laboratory, all three facilities supported by the DOE Office of Science. "At the DOE laboratories, we have the highest resolution microscopes in the world, so we really went full bore into characterizing the atomic structure," Stach said.

"Our studies revealed that Ruoff's hypothesis was in fact correct, and that the material's three-dimensional nanoscale structure consists of a network of highly curved, single-atom-thick walls forming tiny pores with widths ranging from 1 to 5 nanometers, or billionths of a meter."

The study includes detailed images of the fine pore structure and the carbon walls themselves, as well as images that show how these details fit into the big picture. "The data from NSLS were crucial to showing that our highly local characterization was representative of the overall material," Stach said.

"We're still working with Ruoff and his team to pull together a complete description of the material structure. We're also adding computational studies to help us understand how this three-dimensional network forms, so that we can potentially tailor the pore sizes to be optimal for specific applications, including capacitive storage, catalysis, and fuel cells," Stach said.

Meanwhile, the scientists say the processing techniques used to create the new form of carbon are readily scalable to industrial production. "This material -- being so easily manufactured from one of the most abundant elements in the universe -- will have a broad range impacts on research and technology in both energy storage and energy conversion," Ruoff said.

Story Source:

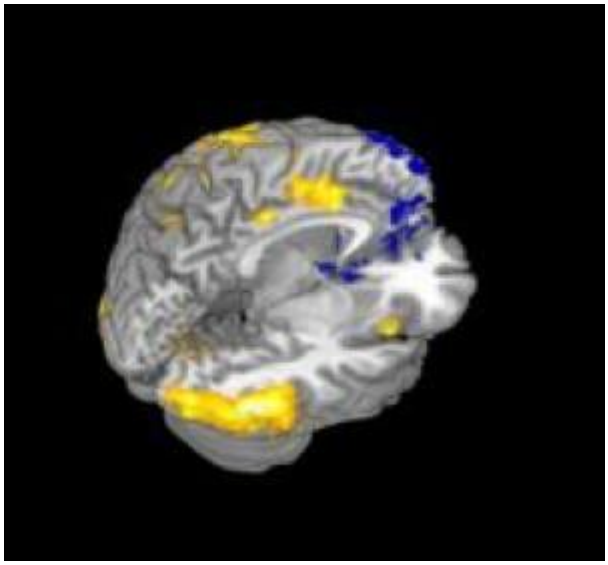
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **DOE/Brookhaven National Laboratory**.

Journal Reference:

1. Yanwu Zhu, Shanthi Murali, Meryl D. Stoller, K. J. Ganesh, Weiwei Cai, Paulo J. Ferreira, Adam Pirkle, Robert M. Wallace, Katie A. Cychosz, Matthias Thommes, Dong Su, Eric A. Stach and Rodney S. Ruoff. **Carbon-Based Supercapacitors Produced by Activation of Graphene**. *Science*, 12 May 2011 DOI: 10.1126/science.1200770

http://www.sciencedaily.com/releases/2011/05/110512150731.htm

Guilt, Cooperation Linked by Neural Network: Why People Choose to Cooperate Rather Than Act Selfishly



The fMRI image above depicts areas of the brain associated with the competing motivations of minimizing guilt (yellow) and maximizing financial reward (blue) when participants decide whether or not they want to honor an investment partner's trust. The motivation to minimize guilt is associated with the insula, anterior cingulate cortex and supplementary motor area (yellow). The motivation to maximize financial reward is associated with the ventral striatum, ventromedial prefrontal cortex and dorsomedial prefrontal cortex. (Credit: Image courtesy Luke Chang/UA psychology department)

ScienceDaily (May 12, 2011) — A team of researchers at the University of Arizona has brought a high-tech tool to bear on the study of a familiar and age-old emotion -- guilt.

What makes the investigation unique is the use of fMRI scans to target the regions of the brain associated with guilt. It also opens a new avenue in understanding behavioral disorders associated with guilt, such as depression and anxiety.

The study is published by Cell Press in the journal *Neuron*.

The authors -- Luke Chang, Alec Smith, Martin Dufwenberg and Alan Sanfey -- also come from two seemingly disparate areas: cognitive neuroscience and economics.

Sanfey is a recognized neuroscientist who also has an appointment at the Donders Institute at Radboud University in The Netherlands, and Chang is a doctoral student in the UA psychology department.

Dufwenberg is a behavioral economist in the UA Eller College of Management. Smith, a former doctoral student in Eller's economics department, is now a post-doctoral scholar in economics at the California Institute of Technology.

The collaboration began when Dufwenberg and Smith were "reaching out for people who would be interested" in cross-disciplinary partnerships when they met and teamed up with Sanfey and Chang.

Guilt, in this case the failure to live up to the expectations of others. It is an emotion that likely has its roots in the evolutionary history of humans. And the aversion to guilt is a factor in motivating cooperative behavior.

The thrust of the study, said Chang, is trying to understand why people cooperate.

"One idea is that most people cooperate because it feels good to do it. And there is some brain imaging data that shows activity in reward-related regions of the brain when people are cooperating.

"But there is a whole other world of motivation to do good because you don't want to feel bad. That is the idea behind guilt aversion," Chang said.

To test this, 30 volunteers played a game appropriate for testing a mathematical theory of guilt aversion that Dufwenberg devised. In it, "investors" were asked to award a certain amount of money to a "trustee," whose expectations regarding how much the investor expected to get back were elicited. The trustees were then scanned using fMRI while deciding how much money should be returned to their investors.

"The theory will then operate on the expectations the players have," said Dufwenberg. "I would feel guilt if I give you less than I believe that you expect that you will get. Then we measure expectations in the experimental situation. The theory predicts when people will experience guilt. Then we see how that correlates with brain activity."

The fMRI scans identified regions in the brain involved in guilt-motivated cooperation while test subjects made their decisions whether or not to honor a partner's trust. Different areas of the brain became active during those decisions based on their choosing to cooperate, or to abuse the trust and maximize their own financial gain.

The report said the results show that "a neural system previously implicated in expectation processing plays a critical role in assessing moral sentiments that in turn can sustain human cooperation in the face of temptation."

Civilized society is based on cooperation and trust, from behaviors a simple and informal as opening a door for someone carrying heavy packages or tipping a restaurant server to complex legal agreements between corporations or countries. Understanding the neural structures behind these behaviors promises to offer new insights into complex behaviors of trust and reciprocity.

Chang said the collaboration among economists, psychologists and neuroscientists is instrumental in understanding the biological mechanisms underlying complex social behavior, such as guilt, and has real world implications for understanding clinical disorders such as depression anxiety and psychopathy.

Alan Sanfey, the senior author of the study, said "the study demonstrates the potential in cross-disciplinary collaborations of this nature, for example, in developing more complete models of how people make decisions in complex social situations."

As a behavioral economist, Dufwenberg argues that factors such as emotions may be important drivers of economic outcomes, and that the mathematical models that economists use can be augmented to include such psychological aspects.

"In the end, it's a two-way exchange. Economists take inspiration from the richer concept of man usually considered in psychology, but at the same time they have something to offer psychologists through their analytical tools.

"Remember how guilt depends on beliefs about beliefs about outcomes? These are hard to observe, hard to test. I'm excited about the idea of using neuroscience tools to test economic theory."

E

Story Source:

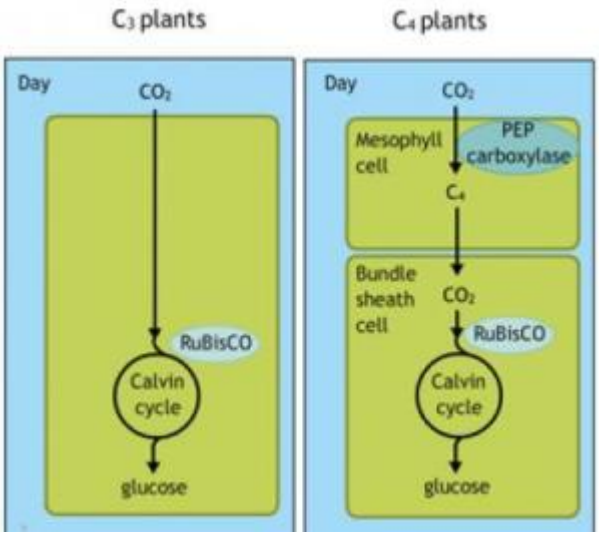
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of Arizona**. The original article was written by Jeff Harrison, University Communications.

Journal Reference:

1. Luke J. Chang, Alec Smith, Martin Dufwenberg, Alan G. Sanfey. **Triangulating the Neural, Psychological, and Economic Bases of Guilt Aversion**. *Neuron*, 2011; 70 (3): 560-572 DOI: 10.1016/j.neuron.2011.02.056

http://www.sciencedaily.com/releases/2011/05/110511131126.htm

Improving Photosynthesis? Solar Cells Beat Plants at Harvesting Sun's Energy, for Now



RuBisCO crucial photosynthetic enzyme sometimes reacts with oxygen rather than carbon, then goes through a long, complicated and energy-expensive process called photorespiration just to recover the carbon and get it back to the starting line. Scientists are trying to fix the problem by stealing ideas from C4 plants. C4 plants (right) prevent RuBisCO from binding oxygen by concentrating carbon dioxide in special photosynthetic cells called bundle-sheath cells. The high concentrations of carbon dioxide in these cells suppress oxygen binding, allowing RuBisCO to work more efficiently. (Credit: Viten, a service of the Norwegian Centre for Science Education)

ScienceDaily (May 12, 2011) — In a head-to-head battle of harvesting the sun's energy, solar cells beat plants, according to a new paper in *Science*. But scientists think they can even up the playing field, says researcher David Kramer at Michigan State University.

Plants are less efficient at capturing the energy in sunlight than solar cells mostly because they have too much evolutionary baggage. Plants have to power a living thing, whereas solar cells only have to send electricity down a wire. This is a big difference because if photosynthesis makes a mistake, it makes toxic byproducts that kill the organism. Photosynthesis has to be conservative to avoid killing the organisms it powers.

"This is critical since it's the process that powers all of life in our ecosystem," said Kramer, a Hannah Distinguished Professor of Photosynthesis and Bioenergetics. "The efficiency of photosynthesis, and our ability to improve it, is critical to whether the entire biofuels industry is viable."

The annually averaged efficiency of photovoltaic electrolysis based on silicon semiconductors to produce fuel in the form of hydrogen is about 10 percent, while a plant's annually averaged efficiency using photosynthesis to form biomass for fuel is about 1 or 2 percent.

Plants, following the path of evolution, are primarily interested in reproducing and repairing themselves. The efficiency at which they produce stored solar energy in biomass is secondary.

Still, things can change.

Just as early Native Americans manipulated skinny, non-nutritious Teosinte into fat, juicy kernel corn, today's plants can be manipulated to become much better sources of energy.

Researcher Arthur J.Nozik, a NREL senior research fellow, and Senior Scientist Mark Hanna working at DOE's National Renewable Energy Laboratory (NREL), recently demonstrated how a multi-junction, tandem solar cell for water splitting to produce hydrogen can provide higher efficiency -- more than 40 percent -- by using multiple semiconductors and/or special photoactive organic molecules with different band gaps arranged in a tandem structure.

The coupling of different materials with different gaps means photons can be absorbed and converted to energy over a wider range of the solar spectrum.

"In photovoltaics, we know that to increase power conversion efficiency you have to have different band gaps (i.e., colors) in a tandem arrangement so they can more efficiently use different regions of the solar

spectrum," Nozik said. "If you had the same gap, they would compete with each other and both would absorb the same photon energies and not enhance the solar conversion efficiency."
Photosynthesis does use two gaps based on chlorophyll molecules to provide enough energy to drive the photosynthesis reaction. But the two gaps have the same energy value, which means they don't help each other to produce energy over a wider stretch of the spectrum of solar light and enhance conversion efficiency. Furthermore, most plants do use the full intensity of sunlight but divert some of it to protect the plant from damage. Whereas photovoltaics use the second material to gain that photoconversion edge, plants do not, Nozik noted.
One of NREL's roles at the DOE workshop was to help make it clear how the efficiency of photosynthesis could be improved by re-engineering the structure of plants through modern synthetic biology and genetic manipulation based on the principles of high efficiency photovoltaic cells, Nozik said. In synthetic biology plants can be built from scratch, starting with amino acid building blocks, allowing the formation of optimum biological band gaps.
The newly engineered plants would be darker, incorporating some biological pigments in certain of nature's flora that would be able to absorb photons in the red and infrared regions of the solar spectrum.
As plants store more solar energy efficiently, they potentially could play a greater role as alternative renewable fuel sources. The food that plants provide also would get a boost. And that would mean less land would be required to grow an equivalent amount of food.
The new information in the *Science* manuscript will help direct the development of new plants that have a better propensity for reducing carbon dioxide to biomass. This could spur exploration of blue algae, which not only comprise about one quarter of all plant life, but are ideal candidates for being genetically engineered into feedstock, because they absorb light from an entirely different part of the spectrum compared to most other plants.
"It would be the biological equivalent of a tandem photovoltaic cell," said Robert Blankenship, one of the lead authors in the *Science* paper who studies photosynthesis at Washington University in St. Louis. "And those can have very high efficiencies."

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

Journal Reference:

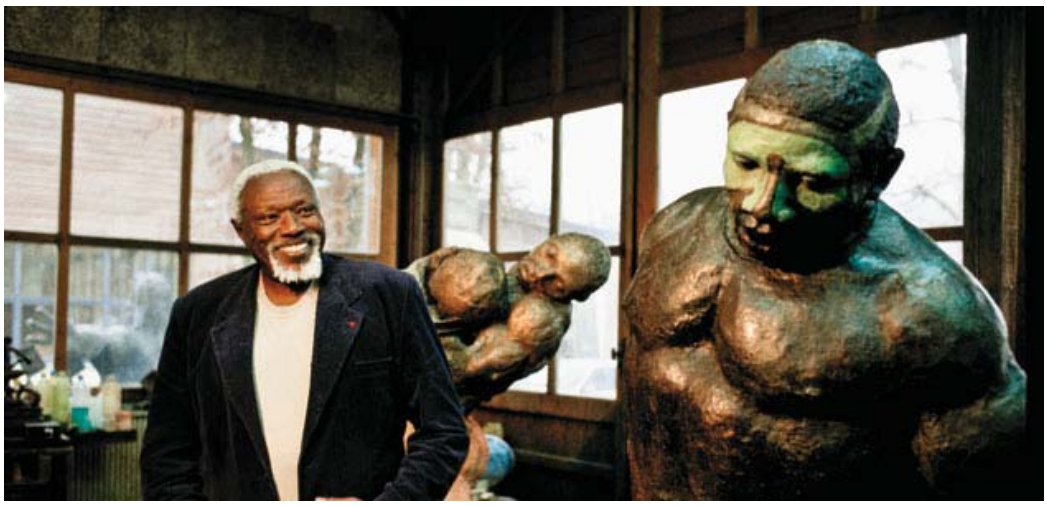
1. Robert E. Blankenship et al. **Comparing Photosynthetic and Photovoltaic Efficiencies and Recognizing the Potential for Improvement**. *Science*, 13 May 2011: Vol. 332 no. 6031 pp. 805-809 DOI: 10.1126/science.1200165

http://www.sciencedaily.com/releases/2011/05/110512151408.htm

A Larger-Than-Life Toussaint Louverture

The Haitian revolutionary joins the Smithsonian Museum of African Art's collection

- By Owen Edwards
- *Smithsonian* magazine, May 2011



An imposing sculpture by Senegalese artist Ousmane Sow—the centerpiece of a new exhibition, "African Mosaic," which highlights recent acquisitions at the Smithsonian National Museum of African Art—depicts the 18th-century Haitian revolutionary Toussaint Louverture. The figure, more than seven feet tall, portrays Toussaint reaching out to a seated female slave. "The 'Great Man' theory of history is no longer popular," says curator Bryna Freyer. "But it's still a way of looking at Toussaint. He really was larger than life."
The sculpture, which museum director Johnnetta Cole describes as "our Mona Lisa," evokes two men—the celebrated rebel of Haitian history and the artist who pays homage to him.
In 1743, Toussaint Louverture was born into bondage in Haiti, the French island colony then known as Saint-Domingue, possibly the grandson of a king from what is now the West African nation of Benin. He is thought to have been educated by his French godfather and Jesuit missionaries. Toussaint read widely, immersing himself in writings from the Greek philosophers to Julius Caesar and Guillaume Raynal, a French Enlightenment thinker who inveighed against slavery. In 1776, at the age of 33, Toussaint was granted his freedom from the place he was born, Breda Plantation, but remained on, rising to positions in which he assisted the overseer. He also began to acquire property and achieved a level of prosperity.
In 1791, while France was distracted by the turmoil of the revolution, a slave rebellion began in Haiti. Toussaint quickly got involved; perhaps as repayment for his education and freedom, he helped Breda's white overseers and their families flee the island. Toussaint (who added Louverture to his name, a reference either to his military ability to create tactical openings or to a gap in his teeth, caused when he was hit by a spent musket ball) quickly rose to the rank of general—and eventually the leader of the independence movement. His forces were sometimes allied with the Spanish against the French, and sometimes with the French against the Spanish and English. In 1799, he signed a trade pact with the administration of President John Adams. Ultimately, Toussaint considered himself to be French and wrote to Napoleon declaring his loyalty. Bonaparte was neither impressed nor forgiving. In late 1801, he dispatched 20,000 French troops to reclaim the island. Although Toussaint negotiated an amnesty and retired to the countryside, he was seized and sent to a prison in France. There, he died of pneumonia in 1803. In death, as in life, Toussaint was lionized. Wordsworth, no friend of the French, wrote a memorial sonnet, "To L'Ouverture," attesting to the fallen leader's enduring fame: "There's not a breathing of the common wind / That will forget thee."
Sculptor Ousmane Sow (rhymes with "go") created the Toussaint figure in 1989 in Dakar, Senegal. The museum acquired the piece in 2009. Born in 1935 in Dakar, Sow left for Paris as a young man. "He worked as

a physical therapist, which gave him a good knowledge of human anatomy," says curator Freyer. "And he spent hours at Parisian museums, looking at the works of sculptors such as Rodin and Matisse."

Sow has often chosen historic themes and heroic characters—he has completed a 35-piece work about the Battle of Little Big Horn, a series on Zulu warriors and a bronze statue of Victor Hugo. A large man himself—Sow stands well over six feet tall—the artist seems to favor large-scale pieces. Karen Milbourne, a curator at the museum who has visited Sow's studio in Senegal, describes an outsize depiction he did of his father. "Because it's so large and imposing," she recalls, "it's as if you're seeing it [from the perspective of] a child."

Ordinarily, when discussing sculpture, there is mention of what it's made of—stone or bronze, wood or terra cotta. Sow works in his own unique medium, creating pieces from a farrago of ingredients that may include soil, straw, cement, herbs and other things, according to an ever-changing recipe. "It's his secret sauce," says curator Christine Kreamer. The mixture is allowed to age for weeks or months, and then is applied to a metal framework. According to Freyer, Sow has also used the mysterious substance to waterproof his house.

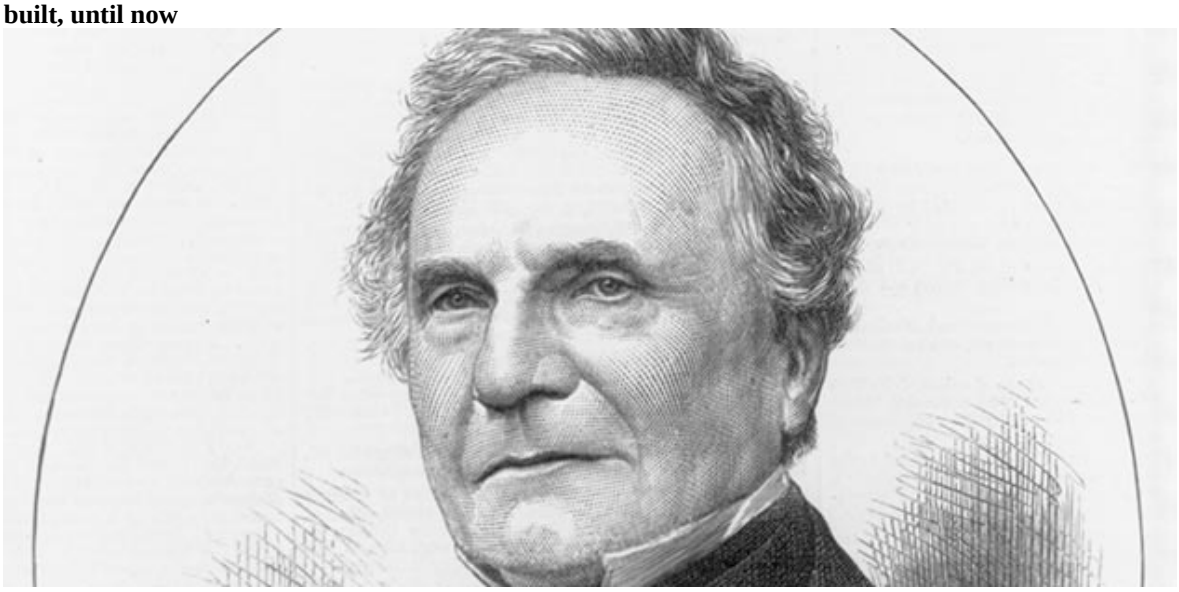
For his part, Sow doesn't attempt to define his work's effect: "I don't have much to say; my sculptures say it all," he says.

Owen Edwards is a freelance writer and author of the book *Elegant Solutions.*

Find this article at:
http://www.smithsonianmag.com/arts-culture/A-Larger-Than-Life-Toussaint-Louverture.html

Booting Up a Computer Pioneer's 200-Year-Old Design

Charles Babbage, the grandfather of the computer, envisioned a calculating machine that was never built, until now



- By Aleta George
- Smithsonian.com, April 02, 2009

When today's number crunchers want to make quick calculations, they reach for their smartphone, a device practically unimaginable two centuries ago. But in the 1820s, at least one forward-thinking mathematician envisioned a calculating machine, albeit far from portable. Frustrated by the human errors he found in printed numerical tables, English inventor Charles Babbage designed a machine to perform mathematical functions and automatically print the results. His initial design, which called for 25,000 parts, would have weighed 15 tons and been about the size of a horse-drawn carriage.

The plans looked good on paper, but Babbage was never able to build his machine. More than a century after his death in 1871, computer historians blew the dust off his 5,000 pages of notes and drawings and wondered if his ideas could work. In 1991, on the bicentennial of Babbage's birth, the Science Museum in London unveiled his Difference Engine No. 2, a fully functioning calculating machine, built to the specs of the inventor's drawings. A full-scale clone of that machine is now on display in Mountain View, California, at the Computer History Museum through December 2009.

Babbage called his invention a "difference engine" because its function is based on the mathematical principle of finite differences, which calculates complex mathematical functions by repeated addition without the use of multiplication or division. Constructed in a cast-iron frame, the machine on display is 11 feet long and 7 feet tall. With each turn of its crank, steel and bronze cams and rods spring into precise action, clicking softly like a Victorian clock. Spinning steel brackets and columns of gearwheels, which represent numbers, create a fluid mechanized helical dance. There are no touch screens, of course, but after four cranks, the machine can calculate an algebraic equation in six seconds.

Babbage was born in 1791 at the onset of England's Industrial Revolution. He studied at Cambridge, and thanks to an inheritance from his wealthy father, had leisure time to think about how things worked and improve on them. Babbage invented the cowcatcher, a device on the front of a train that clears debris without slowing the train. He also improved lighthouse signaling and created a quick-release system for railway carriages. Living amid all the wondrous changes wrought by the industrial age, Babbage, surveying yet another error-ridden set of printed numerical tables, once exclaimed: "I wish to God these calculations had been executed by steam!"

Up until 40 years ago, engineers, navigators, astronomers and bankers used slide rules and books of tables to perform calculations. “The defining event which brought the end of the slide rule and the books of tables was in 1972, when Hewlett-Packard introduced the HP-35,” says the computer museum’s senior docent, Tim Robinson. “This was the first hand-held, full-function scientific calculator that replaced all the normal functions of tables and the slide rule.”

Though the exact creator of the very first calculator is debatable, Babbage is counted among the pioneers who designed a machine that could reliably compute equations. In an attempt to build his difference engine in the 1830s, Babbage secured funding from the British government and commissioned engineer and toolmaker Joseph Clement to make the 25,000 parts. When Clements had finished about half the parts, he and Babbage had an irreconcilable dispute and the project was halted.

After a decade of work, all Babbage had to show for his efforts was a small demonstration machine, used to impress parlor guests at his Saturday soirees. Both Charles Dickens and Charles Darwin turned the handle of the machine that was considered an engineering breakthrough for its time. Often referred to as the “beautiful fragment,” it is one of the most prized artifacts in the London Science Museum.

Once he lost his financial backers for the calculating machine, Babbage designed and partially built an ambitious device he would call the “Analytical Engine.” Tinkering with it for many years, he applied many of the same principles and features found in today’s computers, including programmable punch cards and iteration. It is mainly because of his Analytical Engine that Babbage is considered the “grandfather of the computer.”

“He was a thoroughly modern thinker in how he thought about computing,” said former Microsoft technology officer Nathan Myhrvold in a lecture at the Computer History Museum.

Using what he had learned developing the Analytical Engine, Babbage modified the design of his difference calculating machine but died before he could build it. Toward the end of the 20th century, several computer geeks pored over his designs. Doron Swade, then the curator of computing at the Science Museum in London, decided to build the Difference Engine No. 2 without knowing for sure if it would work. It took him 17 years, but when he finished, it worked just as Babbage said it would.

The difference engine was nearly ready for Babbage’s birthday celebration, but the project ran out of money before completion of the machine’s typeset and print functions. When Microsoft’s Bill Gates saw the work in progress, he suggested that Myhrvold, who's an inventor, archaeologist and investor, might finance the completion of it. Only if the London Museum agreed to build a working replica for his private collection, Myhrvold said in sealing the deal. After the colossal calculator leaves the Silicon Valley museum, it’s bound for Myhrvold’s home in Seattle, perhaps joining the Tyrannosaurus rex skeleton in his living room.

Meanwhile, the machine is demonstrated Wednesday through Friday at 2 p.m. and on weekends at 1 and 2 p.m. During a recent visit, a docent turned the crank of the foot-wide wheel, putting her back into it. As the gears and cams clicked into motion, one onlooker remarked that the movement looked like the double helix of DNA. The audience seemed mesmerized by the calculator’s elegant precision. At long last, Babbage’s genius was getting its due.

Find this article at:
http://www.smithsonianmag.com/science-nature/Booting-Up-a-Computer-Pioneers-200-Year-Old-Design.html

In Search of the Mysterious Narwhal

Ballerina turned biologist Kristin Laidre gives her all to study the elusive, deep-diving, ice-loving whale known as the "unicorn of the sea"

- By Abigail Tucker
- *Smithsonian* magazine, May 2009

Even before the hunters were off the phone, Kristin Laidre was out of her pajamas and struggling into a survival suit. She ran down to the beach, where a motorboat awaited. The night was frigid with ice-chip stars; the northern lights glowed green overhead. Laidre and a colleague sped past looming bergs and black cliffs plated with ice to the spot offshore where the villagers' boats were circling. The whale was there, a thrashing ton of panic amid the swells. Laidre could see its outline in the water and smell its sour breath.

The scientists and hunters maneuvered boats and began hauling in the nylon net that had been strung from shore and floated with plastic buoys. It was exceptionally heavy because it was soaking wet and, Laidre would recall, "there was a whale in it." Once the mottled black animal was in a secure hammock, they could slip a rope on its tail and a hoop net over its head and float it back to the beach to be measured and tagged. But something was wrong. The whale seemed to be only partially caught—snagged by the head or tail, Laidre wasn't sure. The hunters screamed at each other, the seas heaved and the boats drifted toward the fierce cliffs. The hunters fought to bring the whale up, and for a moment it seemed as if the animal, a big female, was theirs—Laidre reached out and touched its rubbery skin.

Then the whale went under and the net went limp, and with a sinking heart Laidre shined her pale headlamp into water as dark as oil.

The narwhal was gone.

Kristin Laidre did not set out to wrestle whales in the devastatingly cold waters off Greenland's west coast. She wanted to be a ballerina. Growing up near landlocked Saratoga Springs, New York, where the New York City Ballet spends its summer season, she discovered the choreography of George Balanchine and trained throughout her teens to be an elite dancer. After high school, she danced with the Pacific Northwest Ballet, one of the nation's most competitive companies, and while practicing a grueling 12 hours a day performed in *Romeo and Juliet*, *Cinderella* and *The Firebird*.

Wearing hiking boots instead of toe shoes, she still carries herself with a dancer's grace, a perfect surety of movement that suggests she can execute a plié or stand up to a polar bear with equal competence. Laidre's

three-year dance career ended after a foot injury, but she says ballet prepared her rather well for her subsequent incarnation as an arctic biologist and perhaps America's leading expert on narwhals, the shy and retiring cetaceans with the "unicorn horn"—actually a giant tooth—found only in the Greenlandic and Canadian Arctic.

"When you are a ballet dancer you learn how to suffer," Laidre explains. "You learn to be in conditions that aren't ideal, but you persist because you're doing something you love and care about. I have a philosophy that science is art, that there is creativity involved, and devotion. You need artistry to be a scientist."

Like the elusive whale she studies, which follows the spread and retreat of the ice edge, Laidre, 33, has become a migratory creature. After earning undergraduate and doctoral degrees at the University of Washington, she now spends part of her year at its Polar Science Center, and the rest of the time she works with collaborators in Denmark or Greenland, conducting aerial surveys, picking through whale stomachs and setting up house in coastal hunting settlements, where she hires hunters to catch narwhals. Along the way she has learned to speak Danish and rudimentary West Greenlandic.

The Greenlandic phrase she hears most often—whenever the weather blows up or the transmitters malfunction or the whales don't show—is *immaqa aqagu*. Maybe tomorrow.

That's because she's devoted to what she calls "possibly the worst study animal in the world." Narwhals live in the cracks of dense pack ice for much of the year. They flee from motorboats and helicopters. They can't be herded toward shore like belugas, and because they're small (for whales) and maddeningly fast, it's little use trying to tag them with transmitters shot from air rifles. They must be netted and manhandled, although Laidre is trying a variation on an aboriginal method, attaching transmitters to modified harpoons that hunters toss from stealthy Greenlandic kayaks.

"Narwhals are hopelessly hard to see, never come when you want them to, swimming far offshore and underwater the whole time," she says. "You think you'll catch a whale in three weeks, you probably won't. Whole field seasons go by and you don't even see a narwhal. There are so many disappointments. It takes great patience and optimism—those are my two words."

The species is practically a blank slate, which is what drew her to narwhals in the first place—that and the crystalline allure of the Arctic. By now she has analyzed scores of narwhal carcasses and managed to tag and follow about 40 live animals, publishing new information about diving behavior, migration patterns, relationship to sea ice and reactions to killer whales. Much of what the world knows about the narwhal's picky eating habits comes from Laidre's research, particularly a 2005 study that offered the first evidence of the whales' winter diet, which is heavy in squid, arctic cod and Greenland halibut. She is the co-author of the 2006 book *Greenland's Winter Whales*.

Basic questions drive her work. How many narwhals are there? Where do they travel and why? Greenland's government funds part of her expeditions, and her findings influence how the narwhal hunting season is managed. As Greenland modernizes, Laidre hopes to raise public awareness about the whales and their significance to the people and environment of the north. Especially now that the climate seems to be warming, narwhals, Laidre believes, will be seriously affected by melting.

"Most creatures on earth we know a lot more about," Laidre says. "We probably know a lot more about the brains of grasshoppers than we do about narwhals."

The alabaster beluga's dark cousin, the narwhal is not a conventionally beautiful animal. Its unlovely name means "corpse whale," because its splotchy flesh reminded Norse sailors of a drowned body. This speckled complexion is "weird," says James Mead, curator of marine mammals at the Smithsonian's National Museum of Natural History (NMNH); usually, he says, whales are a more uniform color. And unlike other whales, narwhals—which can live more than 100 years—die shortly in captivity, greatly reducing the opportunity to study them. "We've only had a glimpse of the beast," Pierre Richard, a prominent Canadian narwhal specialist, told me.

The whales mate in cracks of ice in the dead of winter, in pitch darkness, when the wind chill can drive the air temperature to minus 60 degrees Fahrenheit. ("Not very romantic," Richard notes.) While shifting currents and winds create breaks in the ice, enabling the animals to surface and breathe, the whales must keep moving to avoid getting trapped. Because of the extreme cold, calves are born husky, about one-third the size of their 12-foot-long, 2,000-pound mothers. Like belugas and bowheads, which also inhabit arctic waters, narwhals are about 50 percent body fat; other whales are closer to 20 or 30 percent. No one has ever seen a submerged

narwhal eat. Laidre led a study of the stomach contents of 121 narwhals that suggested they fast in summer and gorge on fish in winter.

Fond of bottom-dwelling prey like Greenland halibut, narwhals are incredibly deep divers. When Mads Peter Heide-Jorgensen, Laidre's Danish colleague and frequent collaborator, pioneered narwhal-tagging techniques in the early 1990s, his transmitters kept breaking under the water pressure. Five hundred meters, 1,000, 1,500—the whales, which have compressible rib cages, kept plunging. They bottomed out around 1,800 meters—more than a mile deep. At such depths, the whales apparently swim upside down much of the time.

The whales' most dazzling feature, of course, is the swizzle-stick tusk that sprouts from their upper left jaw. Though the whales' scientific name is *Monodon monoceros*, "one tooth, one horn," an occasional male has two tusks (the NMNH has two rare specimens) and only 3 percent of females have a tusk at all. The solitary fang, which is filled with dental pulp and nerves like an ordinary tooth, can grow thick as a lamppost and taller than a man, and it has a twist. On living whales, it's typically green with algae and alive with sea lice at its base. No one's sure precisely how or why it evolved—it has been called a weapon, an ice pick, a kind of dousing rod for fertile females, a sensor of water temperature and salinity, and a lure for prey. Herman Melville joked that it was a letter opener.

"Everybody has a theory on this," Laidre says with a sigh. (The question comes up a lot at cocktail parties.) Most scientists, Laidre included, side with Charles Darwin, who speculated in *The Descent of Man* that the ivory lance was a secondary sex characteristic, like a moose's antlers, useful in establishing dominance hierarchies. Males have been observed gently jousting with their teeth—the scientific term is "tusking"—when females are nearby. The tooth, Laidre patiently explains, cannot be essential because most females survive without one.

In 2004, Greenland set narwhal-hunting quotas for the first time, despite some hunters' protests, and banned the export of the tusks, halting a thousand-year-old trade. Conservationists—newly roiled this past summer by the discovery of dozens of dead narwhals in East Greenland, the tusks chopped out of the skulls and the meat left to rot—want still more restrictions. It's estimated there are at least 80,000 of the animals, but nobody knows for sure. The International Union for Conservation of Nature this year said the species was "near threatened."

To track the whales, Laidre and Heide-Jorgensen have collaborated with hunters on Greenland's west coast and were just starting to build relationships in the village of Niaqornat when I asked to tag along. We would arrive in late October and the scientists would remain through mid-November, as darkness descended and the ice glided into the fjords, and the pods of whales, which they suspect summer in Melville Bay several hundred miles north, made their way south. It was a time frame that some of Laidre's colleagues in Seattle, many of them climate scientists who prefer to study the Arctic via buoy and robotic plane, considered vaguely insane. Laidre, of course, was optimistic.

When Laidre, Heide-Jorgensen and I first reached the village, after a two-hour boat ride that involved rounding icebergs in the inky blackness of a late arctic afternoon, the sled dogs greeted us like hysterical fans at a rock concert while villagers crowded the boat, reaching in to pull out our luggage and hollering at Laidre in Greenlandic.

Niaqornat (pop. 60) is on a tongue of land in Baffin Bay inside the Arctic Circle. The settlement sits hard against a white wall of mountains, where men hunting arctic grouse leave tiny red droplets in their footsteps on the slopes: blackberries crushed under the snow. Greenland has its own home-rule government but remains a Danish possession, and thanks to the Danish influence the town is fully wired, with personal computers glowing like hearths in almost every living room. But none of the houses, including the drafty three-room field station used by Laidre and other scientists, has plumbing or running water; the kerosene stoves that keep the water from freezing are easily puffed out by the ripping wind, which also brings waves bashing against the town's scrap of black beach.

With its tide line of pulverized ice crystals, the beach is the chaotic center of village life, scattered with oil drums, anchors and the hunters' little open boats, some of which are decorated with arctic fox tails like lucky giant rabbit's feet. There are waterfront drying racks hung with seal ribs, waxen-looking strips of shark and other fish, and the occasional musk ox head masked with ice. Throughout the town, sled dogs are staked to the frozen ground; there are at least three times as many dogs as people.

Signs of narwhals are everywhere, especially now that the tusk market has been shut down and hunters can't sell the ivory for gas money and other expenses. The whales' undeveloped inner teeth are strung up over front

porches like clothespins on a line. A thick tooth is proudly mounted on the wall of the little building that serves as the town hall, school, library and church (complete with sealskin kneelers). It seems the fashion to lean a big tusk across a house's front window.

"There are months when no supplies are coming into the town, and people depend only on what they pull out of the sea," Laidre told me. "The arrival of these whales is a small window of opportunity, and hunters have to have an extremely deep knowledge of how they behave."

The narwhals typically arrive in November, darting into the fjord in pursuit of gonatus squid, and Niaqornat men in motorboats shoot the animals with rifles. But in the springtime, when the whales pass by again on their way north, the hunters work in the old way, driving their dog sleds out into the ice-covered fjord. Then they creep in single file, wearing sealskin boots so as not to make a sound—even a clenched toe can make the ice creak. They get as close as they can to the surfacing whales, then hurl their harpoons.

In the darkness they can tell the difference between a beluga and a narwhal by the sound of their breathing. And if the hunters can't hear anything, they search them out by smell. "They smell like blubber," a young man told me.

During the Middle Ages, and even earlier, narwhal tusk was sold in Europe and the Far East as unicorn horn. Physicians believed that powdered unicorn horn could cure ills from plague to rabies and even raise the dead. It seems also to have been marketed as a precursor to Viagra, and it rivaled snake's tongue and griffin's claw as a detector of poison. Since poisonings were all the rage in medieval times, "unicorn horn" became one of the most coveted substances in Europe, worth ten times its weight in gold. French monarchs dined with narwhal-tooth utensils; Martin Luther was fed powdered tusk as medicine before he died. The ivory spiral was used to make the scepter of the Hapsburgs, Ivan the Terrible's staff, the sword of Charles the Bold.

Historians have not definitively identified where the ancient tusks originated, though one theory is that the narwhals were harvested in the Siberian Arctic (where, for unknown reasons, they no longer live). But in the late 900s the Vikings happened upon Greenland, swarming with narwhals, their teeth more precious than polar bear pelts and the live falcons they could hawk to Arabian princes. Norse longboats rowed north in pursuit of the toothed whales, braving summer storms to trade with the Skraelings, as the Vikings called the Inuit, whom they despised.

It was Laidre's intellectual ancestors, the Enlightenment scientists, who ruined the racket. In 1638, the Danish scholar Ole Wurm refuted the unicorn myth, showing that the prized horn material came from narwhals, and others followed suit. In 1746, faced with mounting evidence, British physicians abruptly stopped prescribing the horn as a wonder drug (though the Apothecaries' Society of London had already incorporated unicorns into its coat of arms). Today, the tusks fetch more humble prices—about $1,700 a foot at a 2007 auction in Beverly Hills. (It has been illegal to import narwhal tusk into the United States since the 1972 Marine Mammal Protection Act, but material known to have entered the nation earlier can be bought and sold.)

To the Inuit, the whale and its horn are hardly luxury goods. Greenlanders traditionally used every part of the animal, burning its blubber in lamps, using the back sinews to sew boots and clothes and the skin for dog sled traces. The tusks were tools of survival in a treeless landscape, used as sled runners, tent poles and harpoons. The tusks were also bleached and sold whole or carved into figurines (and, yes, Mr. Melville, letter openers).

Even today, when iPods are sold at the Niaqornat village store, narwhals remain a vital source of food. Narwhal meat feeds dogs and fills freezers for the winter, a last nutritional opportunity before total darkness closes over the town like a fist. *Mattak*, the layer of skin and blubber that is eaten raw and rumored to taste like hazelnuts, is an Inuit delicacy.

When an animal is killed, word spreads by radio, and the whole town rushes down to the beach, shouting the hunter's name. After the butchering, families share the carcass, part of a traditional gifting system now almost unknown outside the settlements. "We make a living only because the whales come," Karl-Kristian Kruse, a young hunter, told me. "If narwhals didn't come, there would be nothing here."

The new whale quotas will probably make life more difficult in Niaqornat: before 2004, there were no limits on the number of narwhals hunters could catch, but in 2008 the whole village was allotted only six. "The scientists want to know how many whales there are," Anthon Moller, a 25-year-old hunter, said bitterly. "Well, there are a lot, more than ever before. With quotas it's hard to live."

When Laidre and Heide-Jorgensen first showed up to ask for help catching narwhals in nets and then—of all preposterous notions—letting them go, some men thought it was folly, even though the scientists would pay almost as handsomely as the Vikings. Now, two years later, having lost one whale after netting it and

successfully tagging only one other, the hunters still weren't entirely persuaded. And yet, they were curious. They, too, wanted to know where the whales went.

There are no doorbells in Niaqornat, and no knocking. When the town's dozen or so hunters came over to the scientists' house, they just walked in, stomping their big boots politely, to give fair warning as much as to kick off the snow.

They were small, spare men, smelling of fish and wet flannel, with wind-burned skin, flared nostrils and dark eyes. Laidre offered coffee, along with a cake she'd baked that afternoon. They munched watchfully, some of them humming to themselves, while Heide-Jorgensen showed slides of the narwhal tagged in 2007, captured when Laidre was home in Seattle. To catch a unicorn, it is said, you need virgins for bait; to net a narwhal, and transfer it from ocean to beach and back again, a bunkhouse of cowboys would be handier. The whale bucked like a bronco as the hunters, led by one of Laidre's technicians, pinned a transmitter, about the size of a bar of soap, to the dorsal ridge. When at last the tag was secure, the technician was so relieved he smooched the animal's broad back. Then they walked it out with the tide and let it go. One of the hunters had videotaped the entire frothy episode on his cellphone; a year later, the villagers still watched it raptly.

"Kusanaq," Heide-Jorgensen told the hunters. "Beautiful. A great collaboration. This time we'll move the tag back a little and also put on a tusk transmitter."

He explained that he and Laidre would pay: 20,000 Danish kroner, or about $3,700, for a captured beluga, which the scientists were also studying; $4,500 for a *qernertaq*, or narwhal; $5,500 for a *qernertaq tuugaalik*, or tusked narwhal (hunters expect more for males because they're accustomed to selling the tusks); and $6,400 for an *angisoq tuugaaq*, or large tusked narwhal.

The hunters thought this over for a moment, then one raised his hand with a question: What would happen if the whale died?

In that case, the scientists explained, the meat would be divided equally among the villagers.

The scientists also screened a map of the tagged narwhal's travels, its movements traced in green. The whales can migrate more than 1,000 miles in a year. After leaving Niaqornat this one had wandered farther into the fjord in December and January, near Uummannaq, a bigger town with bars and restaurants, where many of the hunters had friends and rivals. Then in March it had turned north toward its summering grounds near Melville Bay, at which point the transmitter stopped working. The hunters eyed the crazy green zigzag with fascination. Though some had seen the data before in weekly e-mail updates from the scientists, it was still astonishing stuff. Some later said they'd enjoy daily updates: they wanted to track the narwhal like traders follow the stock market. When the hunters finally left, full of coffee, cake and respectful criticisms of Laidre's baking, the matter was decided. They would set nets in the morning.

Well, *immaqa aqagu*.

That evening, the temperature, which had sometimes reached the balmy 40s during the day—"Beluga weather," Heide-Jorgensen had said a bit contemptuously—plunged into the teens. Even inside the house, the cold was devouring. All night the wind whooped and the dogs sang and the waves bludgeoned the shore. By morning the dogs had curled into miserable little doughnuts in the snow. The hunters dragged their boats to higher ground. On the hills above town much of the snow had blown away, giving the black earth a dappled appearance, like narwhal skin. No nets would be set today, nor—if the weather report was accurate—for days to come.

"No nets and no underwear," said Laidre, whose personal field gear was due to arrive on a helicopter that almost certainly wouldn't show. "Life is not easy."

At times like these she almost envied colleagues who studied microscopic organisms in jars instead of whales in the raging North Atlantic. Her own brother, a graduate student at Princeton, was researching hermit crabs on the beaches of Ireland, where a cozy pub was never far away. Meanwhile, in Niaqornat, the wind was so vicious that Heide-Jorgensen got trapped in the community bathhouse for hours. The scientists took to singing the Merle Haggard song "If We Make It Through December." For days they made spreadsheets, calibrated transmitters, charged their headlamps—anything to keep busy.

There was some excitement when a young hunter, having learned that I had passed my whole life never having tasted narwhal mattak, arrived with a frozen piece from last year's harvest. (I had asked him what it tasted like, and he said, with a pitying gaze, "Mattak is mattak.") Hazelnut was not the flavor that came to my mind. But Laidre and Heide-Jorgensen tucked away great mouthfuls of the stuff, dipped in soy sauce. In the old days, foreign sailors who abstained from vitamin-C-rich whale mattak sometimes died of scurvy.

Several Niaqornat men who'd been out hunting belugas before the storm were stranded a few hundred miles away, but no one in town expressed concern; in fact, everyone seemed quite merry. Winter's arrival is good news on this part of Greenland's coast, because narwhals always follow the freeze.

The whales' fate is tied to the ice. Narwhal fossils have been found as far south as Norfolk, England, to which the ice cover extended 50,000 years ago. Ice protects narwhals from the orcas that sometimes attack their pods; the killer whales' high, stiff dorsal fins, which are like fearsome black pirate sails, prevent them from entering frozen waters. Even more important, Laidre says, narwhals beneath the pane of ice enjoy almost exclusive access to prey—particularly Greenlandic halibut, which may be why they are such gluttons in winter.

Occupying an icy world has its risks. Narwhals lingering too long in the fjords sometimes get trapped as the ice expands and the cracks shrink; they cut themselves horribly trying to breathe. In Canada this past fall, some 600 narwhals were stranded this way, doomed to drown before hunters killed them. These entrapments are called savssats, a derivative of an Inuit word meaning "to bar his way." Laidre believes that massive die-offs in savssats thousands of years ago may account for the narwhal's extraordinarily low genetic diversity.

Still, less ice could spell disaster for narwhals. Since 1979, the Arctic has lost an ice mass the size of nearly two Alaskas, and last summer saw the second-lowest ice cover on record (surpassed only by 2007). So far the water has opened mostly north of Greenland, but hunters in Niaqornat say they've noticed differences in the way their fjord freezes. Even if warming trends are somehow reversed, Laidre's polar-expert colleagues back in Seattle doubt that the ice will ever regain its former coverage area and thickness. Narwhals may be imperiled because of their genetic homogeneity, limited diet and fixed migration patterns. Laidre was the lead author of an influential paper in the journal *Ecological Applications* that ranked narwhals, along with polar bears and hooded seals, as the arctic species most vulnerable to climate change.

"These whales spend half the year in dense ice," she says. "As the ice's structure and timing changes, the whole oceanography, the plankton ecology, changes, and that affects their prey. Narwhals are a specialist species. Changes in the environment affect them—without a doubt—because they are not flexible."

For the past several years Laidre has been attaching temperature sensors along with tracking gear to captured narwhals. One morning in Niaqornat, she received an e-mail with an analysis of water temperature data collected by 15 tagged narwhals from 2005 to 2007. Compared with historical information from icebreakers, the readings showed warming of a degree or more in the depths of Baffin Bay. Laidre was ecstatic that her collecting method seemed to have worked, though the implications of rising temperatures were disturbing. Indeed, there are already reports of more killer whales in the Arctic.

Once the gales stopped, it was cold but calm: perfect narwhal weather, Heide-Jorgensen declared. I sailed out to set nets with a hunter, Hans Lovstrom, whose boat kept pace with the kittiwakes, pretty gray-winged gulls. We knotted the rope with bare fingers; mine soon became too cold to move. Lovstrom told me to plunge my hands into the water, then rub them vigorously together. I pretended it helped.

Back in the village, social invitations began to flow into the scientists' little house. Would they like to come to a coffee party? A supper of seal soup? Youth night at the school? The colder the weather, the more the community seemed to warm to the scientists. The first time Laidre and Heide-Jorgensen spent a field season in Niaqornat, the village happened to hold a dance party. Someone strummed an electric guitar. Laidre danced with all the hunters, swooping through the steps of the Greenlandic polka, which European whalers had taught the Inuit centuries ago.

That's what everyone had been hollering about when we'd arrived at Niaqornat the first night—they remembered, and admired, the dancing scientist.

As long as the whales keep coming, maybe Greenland's hunting settlements won't be completely absorbed into the growing tourism culture that rents out aluminum igloos to rich foreigners and pays elite hunters to wear polar bear pants in the summertime and toss harpoons for show.

The Sunday before I left Greenland (Laidre would stay for several more weeks), the stranded beluga hunters chugged back to Niaqornat in their boat. Just before darkness fell, people made their way down to the water. Bundled-up babies were lifted high overhead for a better view; older children were ruddy with excitement, because beluga mattak is second only to the narwhal's as winter fare. The dogs yelped as the yellow boat, laminated with ice, pulled into the dock.

Bashful before so many eyes but stealing proud looks at their wives, the hunters spread tarps and then tossed out sections of beluga spine and huge, quivering organs, which landed with a slap on the dock. Last of all

came the beluga mattak, folded in bags, like fluffy white towels. The dismembered whales were loaded into wheelbarrows and spirited away; there would be great feasting that night on beluga, which, like narwhal meat, is nearly black because of all the oxygen-binding myoglobin in the muscle. It would be boiled and served with generous crescents of blubber. The scientists would be guests of honor.

"When I'm old and in a nursing home, I'll think of the friends I have in the Arctic as much as my experiences with whales," Laidre had told me. "And I'm happy that my work helps protect a resource that's so important to their lives."

The hunters had good news, too. Hundreds of miles north, in the endless blackness of ocean and near-permanent night, they had crossed paths with a pod of narwhals, perhaps the first of the season, making their way south toward the fjord.

Abigail Tucker is the magazine's staff writer.

Find this article at:
http://www.smithsonianmag.com/science-nature/In-Search-of-the-Mysterious-Narwhal.html

Fixated by Screens, but Seemingly Nothing Else

By PERRI KLASS, M.D.

The mother had brought in a note from her son's elementary school teacher: *Dear doctor, I think this child needs to be tested for attention deficit disorder.*
"She's worried about how he can't sit still in school and do his work," the mother said. "He's always getting into trouble."
But then she brightened. "But he can't have attention deficit, I know that."
Why? Her son could sit for hours concentrating on video games, it turned out, so she was certain there was nothing wrong with his attention span.
It's an assertion I've heard many times when a child has attention problems. Sometimes parents make the same point about television: My child can sit and watch for hours — he can't have A.D.H.D.
In fact, a child's ability to stay focused on a screen, though not anywhere else, is actually characteristic of attention deficit hyperactivity disorder. There are complex behavioral and neurological connections linking screens and attention, and many experts believe that these children do spend more time playing video games and watching television than their peers.
But is a child's fascination with the screen a cause or an effect of attention problems — or both? It's a complicated question that researchers are still struggling to tease out.

The kind of concentration that children bring to video games and television is not the kind they need to thrive in school or elsewhere in real life, according to Dr. Christopher Lucas, associate professor of child psychiatry at New York University School of Medicine. “It’s not sustained attention in the absence of rewards,” he said. “It’s sustained attention with frequent intermittent rewards.”

The child may be playing for points accumulated, or levels achieved, but the brain’s reward may be the release of the neurotransmitter dopamine. Children with A.D.H.D. may find video games even more gratifying than other children do because their dopamine reward circuitry may be otherwise deficient. Indeed, at least one study has found that when children with A.D.H.D. were treated with methylphenidate (Ritalin), which increases dopamine activity in the brain, they played video games less. The authors suggested that video games might serve as a kind of self-medication for these children.

So increased screen time may be a consequence of A.D.H.D., but some researchers fear it may be a cause, as well. Some studies have found that children who spend more time in front of the screen are more likely to develop attention problems later on.

In a 2010 study in the journal Pediatrics, viewing more television and playing more video games were associated with subsequent attention problems in both schoolchildren and college undergraduates.

The stimulation that video games provide “is really about the pacing, how fast the scene changes per minute,” said Dr. Dimitri Christakis , a pediatrician at the University of Washington School of Medicine who studies children and media. If a child’s brain gets habituated to that pace and to the extreme alertness needed to keep responding and winning, he said, the child ultimately may “find the realities of the world underwhelming, understimulating.”

But a 2007 study in the journal Media Psychology compared television watching in a group of children diagnosed with A.D.H.D. and a group without. The researchers concluded that most differences were accounted for by family factors and environment, including whether the children had televisions in their bedrooms. A.D.H.D. by itself didn’t seem to make the difference. The connections between A.D.H.D. and screens, the authors concluded, were complex.

Elizabeth Lorch, a professor of psychology at the University of Kentucky and one of the authors of that study, also studied children’s ability to comprehend televised stories. While children with A.D.H.D. were able to recall facts from the stories they watched just as well as other children, there was a difference in their ability to understand the narrative and to separate out what was important.

“Why did an event happen, why did a character do this — that’s where the comprehension and recall of children with A.D.H.D. tends to fall down,” she said.

Her co-author Richard Milich, also a professor of psychology at the University of Kentucky, suggested that besides the primary implications of this problem for academic performance, this finding may also shed light on social difficulties.

“This inability to see causal relations may affect this social problem we’ve known for 30 years,” he said. “These kids have dramatic social problems. They’re highly rejected by their peers.”

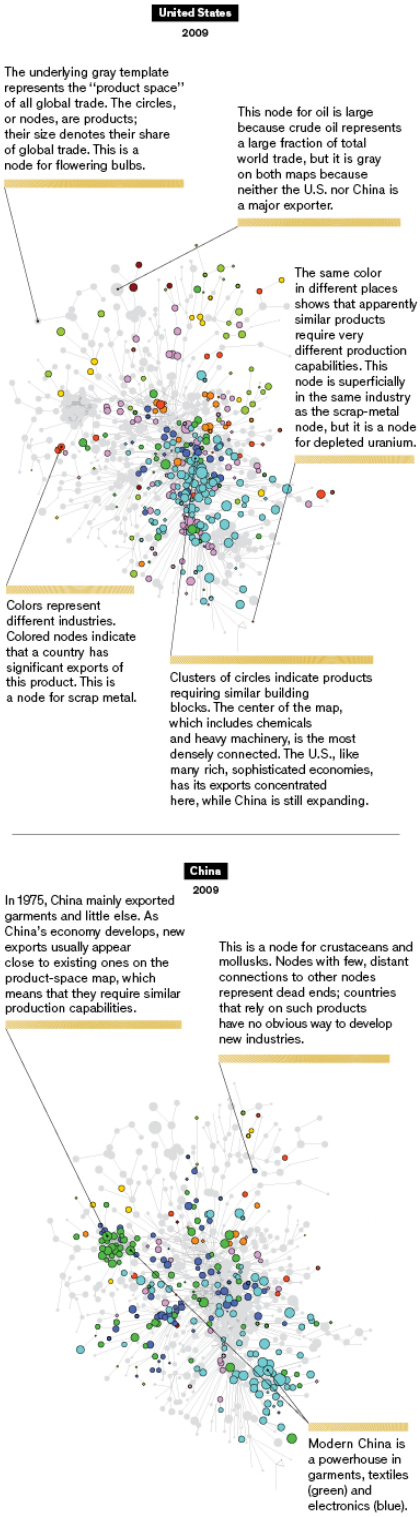
It may be a self-perpetuating loop, experts say: Children who have trouble with their social skills may be thrown back even more to the screen for electronic companionship.

Children whose brains need neurochemical rewards seek out an activity that provides it. Children with social problems spend more time alone, facing a screen. Children struggling in the classroom develop mastery in a virtual world. I talk to parents of children with A.D.H.D. about basic dos and don’ts: No screens in the child’s bedroom. Pay attention to the content of the games, especially to violence. Set limits on screen time, and look for other ways to manage family interactions.

If I can’t tell parents what they hope to hear, at least I can argue that these children’s fascination with the glowing screen may teach us something about their brains, the neurobiology, the rewards, and even the yearning and learning.

http://www.nytimes.com/2011/05/10/health/views/10klass.html?_r=1&nl=health&emc=healthupdateema2

The Art of Economic Complexity



A new way to visualize a country's development.

By TIM HARFORD

Graphic by CÉSAR A. HIDALGO and ALEX SIMOES

These diagrams are the early fruits of a new approach to the most important unsolved problem of the last century: how to make a rich country out of a poor one. Development economists have many theories about how the trick is done but few proven answers. A compelling solution would be useful closer to home, too: understanding the process of economic development would help us work out whether it matters that service jobs are replacing manufacturing ones or whether there is anything the government can and should do to stimulate new industries like biotechnology or green energy.

Strip away the mathematical language of economists, and conventional theories of economic growth are rather crude. Economies produce "stuff," and if you want more stuff to come out of the process, put more stuff in (like human capital, say). Yet economies do not produce stuff so much as billions of distinct types of goods — perhaps 10 billion, according to Eric Beinhocker of the McKinsey Global Institute — ranging from size 34 dark stonewash bootcut jeans to beauty therapies involving avocado. The difference between China's economy and that of the United States is not simply that China's is smaller; it has a different structure entirely. Thanks to César A. Hidalgo of the M.I.T. Media Lab, we can now visualize the differences between national economies in new ways. Hidalgo is a statistical physicist fascinated by the structure of networks, and along with the Harvard economist Ricardo Hausmann, he has been developing tools designed to study not just economic wealth but also economic structure and sophistication. Hidalgo and Hausmann think of economies as collections of "capabilities" that can be combined in different ways like an Erector set to produce different products. An Internet retailer, for instance, cannot function without some kind of electronic-payment network. It also needs a working system of postal addresses — not every country has one — as well as reliable mail. Because these capabilities cannot be easily identified and observed, Hausmann and Hidalgo track the silhouettes that the capabilities cast upon trade statistics. If a product is a significant part of a country's exports, it offers evidence that the country has certain kinds of related capabilities.

Economies that export many types of products are more likely to be sophisticated; products exported only by sophisticated economies are more likely to be complex. Sophistication and wealth do not always go hand in hand. China and India are more complex than their incomes would suggest; Libya's economy is richer than you would expect but also simpler. When economies are relatively sophisticated but relatively poor, they often have the potential for quick growth, as we have seen in China and India.

Hidalgo and Hausmann have also mapped the world's "product space" using trade data on 774 product classifications, from cotton

undergarments to phenols. These are the gray constellations of products in the charts above. The colored circles are major exports of a given economy (in this case, the United States on the left and China on the right). Products are closely connected on the underlying network if they tend to be exported by the same economies. For example, a range of electronic components is exported by a number of economies (which happen to be in East Asia), so those products are clustered together. China is one of these electronics exporters, hence that cluster of products is highlighted. The United States is not.

At the fringes of the product space are development dead ends. Better-connected nodes represent industries that offer promising prospects for growth. Hidalgo can show how economies change in structure over time, moving from simpler goods to scarcer, more valuable ones. Countries rarely make radical structural changes. Instead, they generate capabilities gradually, and new industries usually develop from existing ones. Unfortunately, some industries — oil extraction, say, or fishing — do not naturally lead to anything new without a huge leap.

These product maps lead to an uncomfortable conclusion about economic development: they hint at how difficult and complex it may be for government planners to kick-start a new industry — while showing that there are new industries that will struggle to get started without help.

http://www.nytimes.com/interactive/2011/05/15/magazine/art-of-economic-complexity.html?ref=magazine

Improving the Science of Teaching Science

By BENEDICT CAREY

Over the past few years, scientists have been working to transform education from the inside out, by applying findings from learning and memory research where they could do the most good, in the classroom. A study appearing in the journal Science on Thursday illustrates how promising this work can be — and how treacherous.

The research comes from a closely watched group led by Carl Wieman, a Nobel laureate in physics at the University of British Columbia who leads a $12 million initiative to improve science instruction using research-backed methods for both testing students' understanding and improving how science is taught.

In one of the initiative's most visible studies, Dr. Wieman's team reports that students in an introductory college physics course did especially well on an exam after attending experimental, collaborative classes during the 12th week of the course. By contrast, students taking the same course from another instructor — who did not use the experimental approach and continued with lectures as usual — scored much lower on the same exam.

In teleconference on Wednesday, Dr. Wieman and his co-authors said that some instructors at the university were already eager to adopt the new approach and that it should improve classroom learning broadly, in other sciences and at many levels.

Yet experts who reviewed the new report cautioned that it was not convincing enough to change teaching. The study has a variety of limitations, they said, some because of the difficulty of doing research in the dude-I-slept-through-class world of the freshman year of college, and others because of the study's design. "The whole issue of how to draw on basic science and apply it in classrooms is a whole lot more complicated than they're letting on," said Daniel Willingham, a psychology professor at the University of Virginia.

Dr. Willingham said that, among other concerns, the study was not controlled enough to tell which of the changes in teaching might have accounted for the difference in students' scores.

In the study, Dr. Wieman had two advanced students take over one of the two introductory physics classes during the 12th week of the term, teaching the material in a radically different way from the usual lectures. Both this class and the comparison one were large, lecture-hall courses, each with more than 260 students enrolled. Instead of delivering lectures, the new co-instructors conducted collaborative classes, in which students worked in teams to answer questions about electromagnetic waves. The new teachers circulated among the students, picking up on common questions and points of confusion, and gave immediate feedback on study teams' answers.

The techniques are rooted in an approach to learning known as deliberate practice, which previous research suggests is what leads to the acquisition of real expertise.

"As opposed to the traditional lecture, in which students are passive, this class actively engages students and allows them time to synthesize new information and incorporate it into mental model," said Louis Deslauriers, a postdoctoral researcher who, with Ellen Schelew, a graduate student, taught the experimental classes. "When they can incorporate thing into a mental model, we find much better retention."

At the end of the study, students in the experimental class who took a test on the material scored 74 percent, on average, more than twice the average of students in the comparison course who took the test. On midterm exams the two classes had scored almost exactly the same.

Yet this being college — and the end of the term, at that — not everyone showed up with their calculators. More than 150 of the students were absent from the test, most of them from the comparison class. The researchers had no way to know how those students, if they'd come, would have changed the overall findings.

Experts said, too, that it was problematic for authors of a study to also be delivering the intervention — in this case, as enthusiastic teachers. "This is not a good idea, since they know exactly what the hypotheses are that guide the study, and, more importantly, exactly what the measures are that will be used to evaluate the effects," said James W. Stigler, a professor of psychology at the University of California, Los Angeles, in an e-mail. "They might, therefore, be tailoring their instruction to the assessment — i.e., teaching to the test."

Dr. Wieman said he strongly doubted that the new instructors had this kind of effect on the students. As a rule, he said in an e-mail, students in such large classes "are remarkably removed from any sense of personal connection with the instructor. That does change with a more interactive class, but not enough and not fast enough to have any significant impact on learning in a week."

Either way, Dr. Stigler said, the study is an important step in a journey that is long overdue, given the vast shortcomings of education as usual. “I think that the authors are pioneers in exploring and testing ways we can improve undergraduate teaching and learning,” he said. “As a psychologist, I’m ashamed that it is physicists who are leading this effort, and not learning scientists.”

http://www.nytimes.com/2011/05/13/science/13teach.html?ref=science

Early H.I.V. Therapy Sharply Curbs Transmission

By DONALD G. McNEIL Jr.

People infected with the virus that causes AIDS are far less likely to infect their sexual partners if they are put on treatment immediately instead of waiting until their immune systems begin to deteriorate, according to preliminary results from a large clinical trial released on Thursday.

Patients with H.I.V. were 96 percent less likely to pass on the infection if they were taking antiretroviral drugs — a finding that was so overwhelming that it is likely to change the way American AIDS doctors treat patients and what treatment policies are adopted by the World Health Organization and other countries, said Dr. Anthony S. Fauci, head of the National Institute of Allergy and Infectious Diseases, which paid for the trial.

The data was so convincing that the trial, due to last until 2015, is effectively being ended early.

There have been previous studies, notably among drug abusers in San Francisco and Vancouver, British Columbia, that concluded that starting patients on drugs immediately would stop them from infecting others. Those studies led Unaids, the United Nations AIDS-fighting agency, to adopt "test and treat" as its goal last year; the policy encourages doctors to start people on treatment as soon as they test positive for H.I.V. However, this is the first evidence from a randomized clinical trial, the gold standard in medical research. AIDS prevention specialists not connected to the trial were enthusiastic.

"These results are phenomenal," said Thomas J. Coates, director of the global health program at the University of California, Los Angeles, and the founder of the Center for AIDS Prevention Studies in San Francisco. "It was a tough study to do, and I'm thrilled it came out this way."

Dr. Julio Montaner, an AIDS specialist at the University of British Columbia whose work among Vancouver heroin addicts helped lead to the Unaids policy, called the result of 96 percent protection "as good as it gets." "This is consistent with what we've been saying and doing in British Columbia for close to a decade," he said. "How much more evidence do we need before we implement what we know works?"

The $73 million trial, known as HPTN 052, involved 1,763 couples in 13 cities on four continents. One member of each couple was infected with H.I.V.; the other was not. In half the couples, chosen at random, the infected partner was put on antiretroviral drugs as soon as he or she tested positive for the virus.

In the other half, the infected person started treatment only when his or her CD4 count — a measure of the immune system's strength — dropped below 250 per cubic millimeter.

In 28 of the couples, the uninfected person became infected with the partner's strain of the virus. Twenty-seven of those 28 infections took place in couples in which the partner who was infected first was not yet getting treatment

On Thursday, Dr. Fauci and Dr. Myron Cohen, an AIDS specialist from the University of North Carolina at Chapel Hill and the study's director, announced that the data collected since the study began in 2005 had been "unblinded" to an independent safety review panel, which is standard procedure in clinical trials. When the panel realized how much protection early treatment afforded, it recommended that drug regimens be offered to all participants. Although participants will still be followed, the trial is effectively over because it will no longer be a comparison between two groups on different regimens.

The results carry moral implications for doctors in the United States. Although medical associations like the Infectious Diseases Society of America advocate starting patients on AIDS drugs early, the decision is made by the doctor and patient. Some patients fear the reported side effects of AIDS drugs and want to delay taking the drugs until they get obviously sick or until their CD4 counts fall, and some doctors go along with that, Dr. Fauci said, especially as long as their patients' CD4 counts remain above 350.

But that means the patient may infect others during the delay. Of the 27 people in the study who became infected while their partners were not yet taking the drugs, 17 had partners whose CD4 counts were still above 350.

Asked if it could now be considered immoral for a doctor to accede to a patient's request to delay starting drugs, Dr. Fauci said: "I'm not going to go there. I'm not going to say it's immoral. But there is more and more data showing the advantages of starting as early as you can."

Dr. Coates of U.C.L.A. said he hoped treatment delays would fade away because the newest antiretroviral drugs have few side effects.

Although the evidence suggests that it would be good public health policy to lower infection rates by starting everyone on drugs as soon as they are infected, that is impossible in much of the world. For lack of money, clinics in Africa are turning away patients who are not just infected but close to death. And in some American states where money provided by the Ryan White Act has run out, poor uninsured people are on waiting lists.
Although the trial was relatively large, there are some limitations on interpreting the data.
More than 90 percent of the couples in the trial, who lived in Botswana, Brazil, India, Kenya, Malawi, South Africa, Thailand, the United States and Zimbabwe, were heterosexual.
"We would have liked to have a substantial number of men as potential study subjects, but they just weren't interested," Dr. Cohen said.
Although common sense suggests the results would be similar in the contexts of homosexual sex and sex between people who are not couples, strictly speaking, the results apply only to the type of people studied, Dr. Fauci said.

http://www.nytimes.com/2011/05/13/health/research/13hiv.html?ref=science#

Tiny Variation in One Gene May Have Led to Crucial Changes in Human Brain

On the left, the occipital region of a normal human brain is circled. On the right, the same area of the brain of a subject with mutation of LAMC3 gene is smooth, and lacks normal folds and convolutions. (Credit: courtesy of Yale University)

ScienceDaily (May 15, 2011) — The human brain has yet to explain the origin of one its defining features -- the deep fissures and convolutions that increase its surface area and allow for rational and abstract thoughts.

An international collaboration of scientists from the Yale School of Medicine and Turkey may have discovered humanity's beneficiary -- a tiny variation within a single gene that determines the formation of brain convolutions -- they report online May 15 in the journal *Nature Genetics*.

A genetic analysis of a Turkish patient whose brain lacks the characteristic convolutions in part of his cerebral cortex revealed that the deformity was caused by the deletion of two genetic letters from 3 billion in the human genetic alphabet. Similar variations of the same gene, called laminin gamma3 (LAMC3), were discovered in two other patients with similar abnormalities.

"The demonstration of the fundamental role of this gene in human brain development affords us a step closer to solve the mystery of the crown jewel of creation, the cerebral cortex," said Murat Gunel, senior author of the paper and the Nixdorff-German Professor of Neurosurgery, co-director of the Neurogenetics Program and professor of genetics and neurobiology at Yale.

The folding of the brain is seen only in mammals with larger brains, such as dolphins and apes, and is most pronounced in humans. These fissures expand the surface area of the cerebral cortex and allow for complex thought and reasoning without taking up more space in the skull. Such foldings aren't seen in mammals such as rodents or other animals. Despite the importance of these foldings, no one has been able to explain how the brain manages to create them. The LAMC3 gene -- involved in cell adhesion that plays a key role in embryonic development -- may be crucial to the process.

An analysis of the gene shows that it is expressed during the embryonic period that is vital to the formation of dendrites, which form synapses or connections between brain cells. "Although the same gene is present in

lower organisms with smooth brains such as mice, somehow over time, it has evolved to gain novel functions that are fundamental for human occipital cortex formation and its mutation leads to the loss of surface convolutions, a hallmark of the human brain," Gunel said.

Major funding for the study was provided by National Institute of Neurological Disorders and Stroke through the Recovery Act. Several institutions from Turkey contributed to the paper. Co-lead authors of the paper were Tanyeri Barak and Kenneth Y Kwan of Yale. Other Yale authors include Angeliki Louvi, Murim Choi, Ying Zhu Saliha Yılma, Mehmet Bakırcıoğlu, Ahmet Okay Çağlayan, Ali Kemal Öztürk, Katsuhito Yasuno, Richard A Bronen, Shrikant Mane, Richard P Lifton, Nenad Šestan and Kaya Bilgüvar.

Story Source:

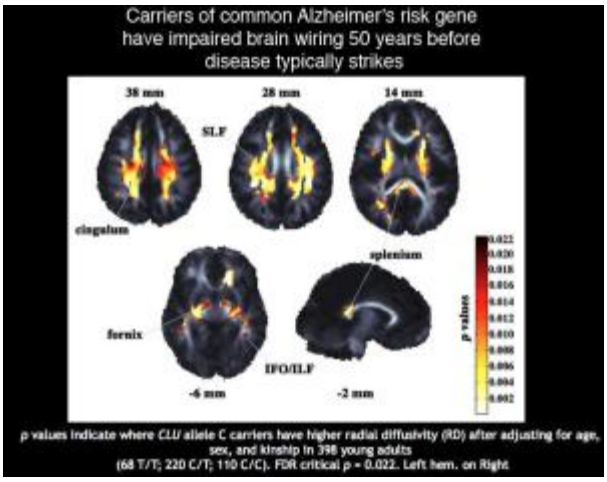
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Yale University**, via EurekAlert!, a service of AAAS.

Journal Reference:

1. Tanyeri Barak, Kenneth Y Kwan, Angeliki Louvi, Veysi Demirbilek, Serap Saygı, Beyhan Tüysüz, Murim Choi, Hüseyin Boyacı, Katja Doerschner, Ying Zhu, Hande Kaymakçalan, Saliha Yılmaz, Mehmet Bakırcıoğlu, Ahmet Okay Çağlayan, Ali Kemal Öztürk, Katsuhito Yasuno, William J Brunken, Ergin Atalar, Cengiz Yalçınkaya, Alp Dinçer, Richard A Bronen, Shrikant Mane, Tayfun Özçelik, Richard P Lifton, Nenad Šestan, Kaya Bilgüvar, Murat Günel. **Recessive LAMC3 mutations cause malformations of occipital cortical development**. *Nature Genetics*, 2011; DOI: 10.1038/ng.836

http://www.sciencedaily.com/releases/2011/05/110515145816.htm

Alzheimer's Risk Gene Disrupts Brain's Wiring 50 Years Before Disease Hits



CLU: Carriers of a common Alzheimer's risk gene have impaired brain wiring, shown here, 50 years before disease typically strikes. (Credit: Image courtesy of UCLA)

ScienceDaily (May 16, 2011) — What if you were told you carried a gene that increases your risk for Alzheimer's disease? And what if you were told this gene starts to do its damage not when you're old but when you're young?

Brace yourself.

Scientists know there is a strong genetic component to the development of late-onset Alzheimer's. In 1993, researchers discovered a gene known as ApoE4 -- carried by about a quarter of us -- that triples the risk for getting Alzheimer's. In 2009, three more risky genes were discovered, and one of them, called clusterin, or CLU, was found to up the risk of getting Alzheimer's by another 16 percent.

But nobody could explain what the CLU gene actually did. Now, UCLA researchers know, and the explanation is a doozy: This risk gene begins to damage your brain a full 50 years before people normally get Alzheimer's.

In the current online edition of the *Journal of Neuroscience*, Paul Thompson, a UCLA professor of neurology, and his colleagues report that the C-allele of the CLU gene (an allele is one of two or more forms of a gene), which is possessed by 88 percent of Caucasians, impairs the development of myelin, the protective covering around the neuron's axons in the brain, making it weaker and more vulnerable to the onset of Alzheimer's much later in life.

The researchers scanned the brains of 398 healthy adults ranging in age from 20 to 30 using a high-magnetic-field diffusion scan (called a 4-Tesla DTI), a newer type of MRI that maps the brain's connections. They compared those carrying a C-allele variant of the CLU gene with those who had a different variant, the CLU T-allele.

They found that the CLU-C carriers had what brain-imaging researchers call lower "fractional anisotropy" -- a widely accepted measure of white-matter integrity -- in multiple brain regions, including several known to degenerate in Alzheimer's. In other words, young, healthy carriers of the CLU-C gene risk variant showed a distinct profile of lower white matter integrity that may increase vulnerability to developing the disease later in life.

The discovery of what this gene does is interesting on several levels, said Thompson, the senior author of the study.

"For example, Alzheimer's has traditionally been considered a disease marked by neuronal cell loss and widespread gray-matter atrophy," he said. "But degeneration of myelin in white-matter fiber pathways is more and more being considered a key disease component and another possible pathway to the disease, and this discovery supports that."

Thompson said four things are surprising with the discovery of this gene's function:

1. This risk gene damages your brain a full 50 years before people normally get Alzheimer's. The damage can be seen on an MRI scan, but there are no symptoms yet.
2. It's now known what this mysterious gene does -- namely, make your brain wiring vulnerable to attack by impairing the wiring before any senile plaques or tangles develop.
3. Rather than being a gene that few people have, a whopping 88 percent of Caucasians have it. "So I guess you could say the other 12 percent have an 'Alzheimer's resistance gene' that protects their brain wiring," said Thompson, who is also a member of UCLA's Laboratory of Neuro Imaging and the UCLA Brain Research Institute.
4. Finally, he said, knowing the role of this gene is useful in predicting a person's risk of the disease and in seeing if you can step in and protect the brain in the 50-year time window you have before the disease begins to develop.

Of course, the obvious question is if most of us have this "bad" gene, why isn't Alzheimer's rampant in young people?

Less myelination in CLU-C carriers may not translate into poorer cognition in youth, said Thompson, because the brain can compensate. "The brain has a lot of built in redundancy -- miles and miles of brain connections," he said. Still, he said, with the passage of time -- and when exacerbated by other factors, such as normal neuron death as we age and plaque and tangle development in the early stages of Alzheimer's -- reduced myelin integrity could facilitate cognitive impairment.

"So it's unlikely we are seeing the earliest possible signs of Alzheimer's-associated brain changes in these young people," Thompson said. "It's more likely the reduced fiber integrity represents an early developmental vulnerability that may reduce brain resilience to later Alzheimer's disease pathology. Inn other words, its mechanism of action may not be part of the classic Alzheimer's pathways that lead to abnormal amyloid plaque and neurofibrillary tangle accumulation in the brain."

The mapping of structural brain differences in those at genetic risk for Alzheimer's disease is crucial for evaluating treatment and prevention strategies, Thompson said. Once identified, brain differences can be monitored to determine how lifestyle choices influence brain health and disease risk.

"We know that many lifestyle factors, such as regular exercise and a healthful diet, may reduce the risk of cognitive decline, particularly in those genetically at risk for Alzheimer's, so this reminds us how important that is," he said.

Other authors included Meredith N. Braskie, Neda Jahanshad, Jason L. Stein, Marina Barysheva, John M. Ringman and Arthur W. Toga from UCLA; Katie L. McMahon and Greig I. de Zubicaray from the University of Queensland in Brisbane, Australia; and Nicholas G. Martin and Margaret J. Wright from the Queensland Institute of Medical Research in Brisbane.

This study was supported by the National Institute of Child Health and Human Development and the National Health and Medical Research Council of Australia; the National Institutes of Health; the UCLA Easton Center for Alzheimer's Disease Research; the NIH/National Library of Medicine; the ARCS Foundation; and the National Institute of Mental Health.

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. M. N. Braskie, N. Jahanshad, J. L. Stein, M. Barysheva, K. L. McMahon, G. I. de Zubicaray, N. G. Martin, M. J. Wright, J. M. Ringman, A. W. Toga, P. M. Thompson. **Common Alzheimer's Disease Risk Variant Within the CLU Gene Affects White Matter Microstructure in Young Adults**. *Journal of Neuroscience*, 2011; 31 (18): 6764 DOI: 10.1523/JNEUROSCI.5794-10.2011

http://www.sciencedaily.com/releases/2011/05/110513091638.htm

'Master Switch' Gene for Obesity and Diabetes Discovered

Scientists have found that a gene linked to type 2 diabetes and cholesterol levels is in fact a "master regulator" gene, which controls the behavior of other genes found within fat in the body. (Credit: iStockphoto)

ScienceDaily (May 15, 2011) — A team of researchers, led by King's College London and the University of Oxford, have found that a gene linked to type 2 diabetes and cholesterol levels is in fact a 'master regulator' gene, which controls the behaviour of other genes found within fat in the body.

As fat plays a key role in susceptibility to metabolic diseases such as obesity, heart disease and diabetes, this study highlights the regulatory gene as a possible target for future treatments to fight these diseases.

Published May 15 in *Nature Genetics*, the study was one part of a large multi-national collaboration funded by the Wellcome Trust, known as the MuTHER study. It involves researchers from King's College London, University of Oxford, The Wellcome Trust Sanger Institute, and the University of Geneva. DeCODE Genetics also contributed to the results reported in this paper.

It was already known that the KLF14 gene is linked to type 2 diabetes and cholesterol levels but, until now, how it did this and the role it played in controlling other genes located further away on the genome was unknown.

The researchers examined over 20,000 genes in subcutaneous fat biopsies from 800 UK female twin volunteers. They found an association between the KLF14 gene and the expression levels of multiple distant genes found in fat tissue, which means it acts as a master switch to control these genes. This was then confirmed in a further independent sample of 600 subcutaneous fat biopsies from Icelandic subjects.

These other genes found to be controlled by KLF14 are in fact linked to a range of metabolic traits, including body-mass index (obesity), cholesterol, insulin and glucose levels, highlighting the interconnectedness of metabolic traits.

The KLF14 gene is special in that its activity is inherited from the mother. Each person inherits a set of all genes from both parents. But in this case, the copy of KLF14 from the father is switched off, meaning that the copy from the mother is the active gene -- a process called imprinting. Moreover, the ability of KLF14 to control other genes was entirely dependent on the copy of KLF14 inherited from the mother -- the copy inherited from the father had no effect.

Professor Tim Spector from the Department of Twin Research at King's, who led the MuTHER project, said: 'This is the first major study that shows how small changes in one master regulator gene can cause a cascade

of other metabolic effects in other genes. This has great therapeutic potential particularly as by studying large detailed populations such as the twins we hope to find more of these regulators.'

Professor Mark McCarthy from the University of Oxford, who co-led the study, said: 'KLF14 seems to act as a master switch controlling processes that connect changes in the behaviour of subcutaneous fat to disturbances in muscle and liver that contribute to diabetes and other conditions. We are working hard right now to understand these processes and how we can use this information to improve treatment of these conditions.'

Story Source:

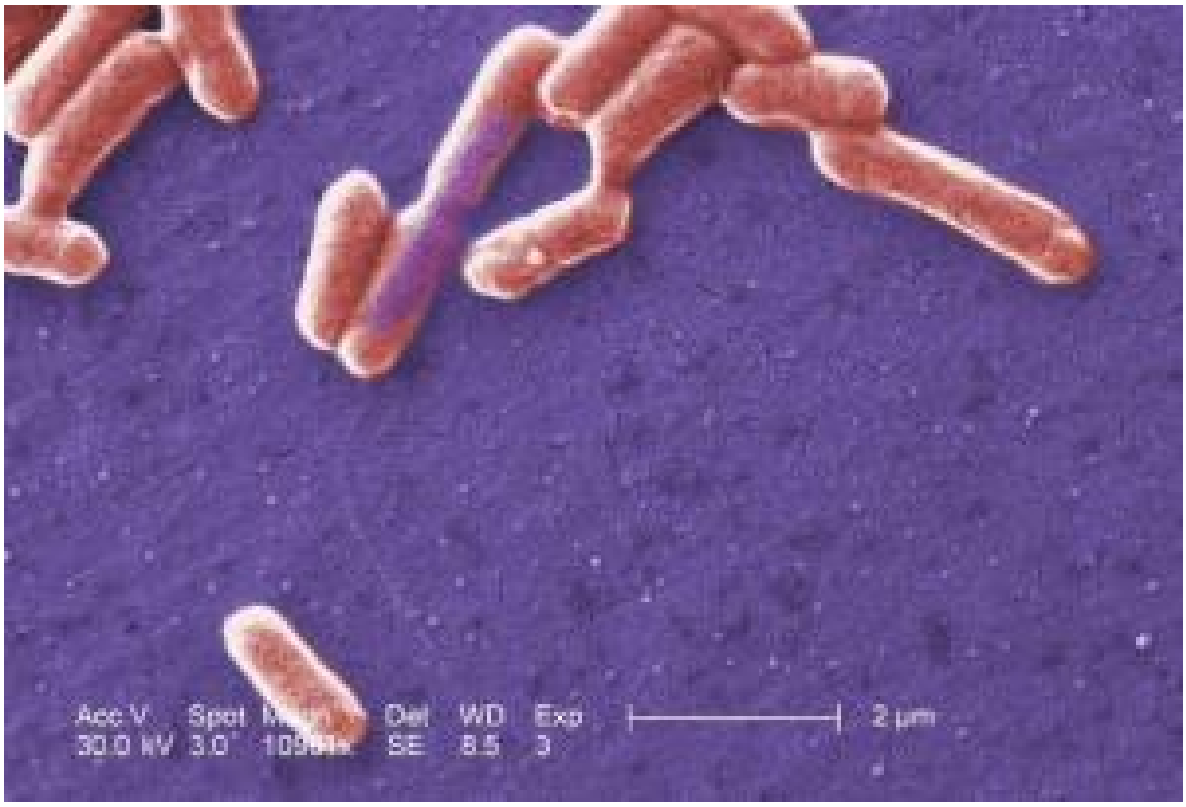
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **King's College London**, via EurekAlert!, a service of AAAS.

Journal Reference:

1. Kerrin S Small, Åsa K Hedman, Elin Grundberg, Alexandra C Nica, Gudmar Thorleifsson, Augustine Kong, Unnur Thorsteindottir, So-Youn Shin, Hannah B Richards, Nicole Soranzo, Kourosh R Ahmadi, Cecilia M Lindgren, Kari Stefansson, Emmanouil T Dermitzakis, Panos Deloukas, Timothy D Spector, Mark I McCarthy. **Identification of an imprinted master trans regulator at the KLF14 locus related to multiple metabolic phenotypes**. *Nature Genetics*, 2011; DOI: 10.1038/ng.833

http://www.sciencedaily.com/releases/2011/05/110515145808.htm

Evolutionary Adaptations Can Be Reversed, but Rarely



Colorized scanning electron micrograph depicted a number of Gram-negative Escherichia coli bacteria. Researchers used an experimental model system to study the evolution of a gene conferring resistance to the antibiotic cefotaxime in bacteria. (Credit: Janice Haney Carr)

ScienceDaily (May 11, 2011) — Physicists' study of evolution in bacteria shows that adaptations can be undone, but rarely. Ever since Charles Darwin proposed his theory of evolution in 1859, scientists have wondered whether evolutionary adaptations can be reversed. Answering that question has proved difficult, partly due to conflicting evidence. In 2003, scientists showed that some species of insects have gained, lost and regained wings over millions of years. But a few years later, a different team found that a protein that helps control cells' stress responses could not evolve back to its original form.

Jeff Gore, assistant professor of physics at MIT, says the critical question to ask is not whether evolution is reversible, but under what circumstances it could be. "It's known that evolution can be irreversible. And we know that it's possible to reverse evolution in some cases. So what you really want to know is: What fraction of the time is evolution reversible?" he says.

By combining a computational model with experiments on the evolution of drug resistance in bacteria, Gore and his students have, for the first time, calculated the likelihood of a particular evolutionary adaptation reversing itself.

They found that a very small percentage of evolutionary adaptations in a drug-resistance gene can be reversed, but only if the adaptations involve fewer than four discrete genetic mutations. The findings will appear in the May 13 issue of the journal *Physical Review Letters*. Lead authors of the paper are two MIT juniors, Longzhi Tan and Stephen Serene.

Gore and his students used an experimental model system developed by researchers at Harvard University to study the evolution of a gene conferring resistance to the antibiotic cefotaxime in bacteria.

The Harvard team identified five mutations that are crucial to gaining resistance to the drug. Bacteria that have all five mutations are the most resistant, while bacteria with none are very susceptible to the drug. Susceptible bacteria can evolve toward resistance by gaining each of the five mutations, but they can't be acquired in any old order. That's because evolution can only proceed along a given path if each mutation along the way offers a survival advantage.

Scientists study these paths by creating a "fitness landscape": a diagram of possible genetic states for a particular gene, and each state's relative fitness in a given environment. There are 120 possible paths through which bacteria with zero mutations could accumulate all five, but the Harvard team found that only 18 could ever actually occur.

The MIT team built on that study by asking whether bacteria could evolve resistance to cefotaxime but then lose it if they were placed in a new environment in which resistance to the original drug hindered their ability to survive.

Genetic states that differ by only one mutation are always reversible if one state is more fit in one environment and the other is more fit in the other. The MIT researchers were able to study how the possibility of reversal decreases as the number of mutations between the two states increased.

"This is the first case where anyone's been able to say anything about how reversibility behaves as a function of distance," Gore says. "What we see in our system is that once the system gets four mutations, it's unable to get back to where it started."

Daniel Weinreich, assistant professor of biology at Brown University, says the study's most important contribution is its analysis of the reversibility between every possible intermediate state in the fitness landscape.

"What Jeff has done is show that there's another layer of mathematical complexity that enters when you ask questions about reversing environmental pressure," says Weinreich, who was not involved in this research.

In the late 19th century, paleontologist Louis Dollo argued that evolution could not retrace its steps to reverse complex adaptations -- a hypothesis known as Dollo's law of irreversibility. Gore says his team's results offer support for Dollo's law, but with some qualifications.

"It's not that complex adaptations can never be reversed," he says. "It's that complex adaptations are harder to reverse, but in a sense that you can quantify."

The study also helps explain why organs no longer needed, such as the human appendix, do not readily disappear. "You can only ever really think about evolution reversing itself if there is a cost associated with the adaptation," Gore says. "For example, with the appendix, it may just be that the cost is very small, in which case there's no selective pressure to get rid of it."

In a follow-up study, the researchers are looking at how the rate of environmental change affects the reversibility of evolution. In the *Physical Review Letters* study, they assumed an immediate switch between two environments, but they believe that more gradual changes might alter the rate of reversal.

Story Source:

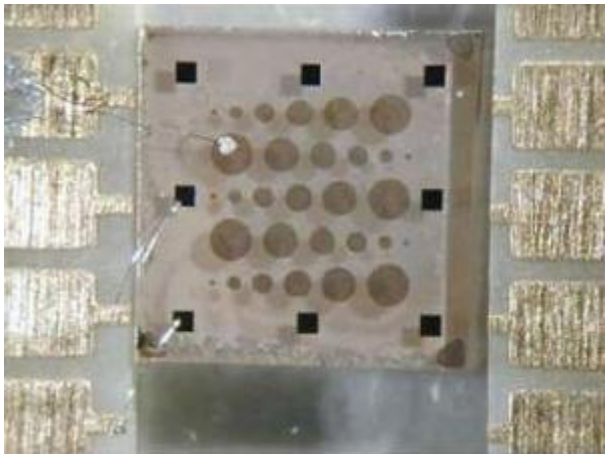
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Massachusetts Institute of Technology**.

Journal Reference:

1. Longzhi Tan, Stephen Serene, Hui Xiao Chao, and Jeff Gore. **Hidden Randomness between Fitness Landscapes Limits Reverse Evolution**. *Physical Review Letters*, 106, 198102 (2011) DOI: 10.1103/PhysRevLett.106.198102

http://www.sciencedaily.com/releases/2011/05/110511162538.htm

Toward Faster Transistors: Physicists Discover Physical Phenomenon That Could Boost Computers' Clock Speed



The researchers' experimental setup consisted of a sample of the lanthanum aluminate-strontium titanate composite, which looks like a slab of thick glass, with thin electrodes deposited on top of it. (Credit: Courtesy of the Ashoori Group)

ScienceDaily (May 15, 2011) — In the 1980s and '90s, competition in the computer industry was all about "clock speed" -- how many megahertz, and ultimately gigahertz, a chip could boast. But clock speeds stalled out almost 10 years ago: Chips that run faster also run hotter, and with existing technology, there seems to be no way to increase clock speed without causing chips to overheat.

In this week's issue of the journal *Science,* MIT researchers and their colleagues at the University of Augsburg in Germany report the discovery of a new physical phenomenon that could yield transistors with greatly enhanced capacitance -- a measure of the voltage required to move a charge. And that, in turn, could lead to the revival of clock speed as the measure of a computer's power.

In today's computer chips, transistors are made from semiconductors, such as silicon. Each transistor includes an electrode called the gate; applying a voltage to the gate causes electrons to accumulate underneath it. The electrons constitute a channel through which an electrical current can pass, turning the semiconductor into a conductor.

Capacitance measures how much charge accumulates below the gate for a given voltage. The power that a chip consumes, and the heat it gives off, are roughly proportional to the square of the gate's operating voltage. So lowering the voltage could drastically reduce the heat, creating new room to crank up the clock.

MIT Professor of Physics Raymond Ashoori and Lu Li, a postdoc and Pappalardo Fellow in his lab -- together with Christoph Richter, Stefan Paetel, Thilo Kopp and Jochen Mannhart of the University of Augsburg -- investigated the unusual physical system that results when lanthanum aluminate is grown on top of strontium titanate. Lanthanum aluminate consists of alternating layers of lanthanum oxide and aluminum oxide. The lanthanum-based layers have a slight positive charge; the aluminum-based layers, a slight negative charge. The result is a series of electric fields that all add up in the same direction, creating an electric potential between the top and bottom of the material.

Ordinarily, both lanthanum aluminate and strontium titanate are excellent insulators, meaning that they don't conduct electrical current. But physicists had speculated that if the lanthanum aluminate gets thick enough, its electrical potential would increase to the point that some electrons would have to move from the top of the

material to the bottom, to prevent what's called a "polarization catastrophe." The result is a conductive channel at the juncture with the strontium titanate -- much like the one that forms when a transistor is switched on. So Ashoori and his collaborators decided to measure the capacitance between that channel and a gate electrode on top of the lanthanum aluminate.

They were amazed by what they found: Although their results were somewhat limited by their experimental apparatus, it may be that an infinitesimal change in voltage will cause a large amount of charge to enter the channel between the two materials. "The channel may suck in charge -- shoomp! Like a vacuum," Ashoori says. "And it operates at room temperature, which is the thing that really stunned us."

Indeed, the material's capacitance is so high that the researchers don't believe it can be explained by existing physics. "We've seen the same kind of thing in semiconductors," Ashoori says, "but that was a very pure sample, and the effect was very small. This is a super-dirty sample and a super-big effect." It's still not clear, Ashoori says, just why the effect is so big: "It could be a new quantum-mechanical effect or some unknown physics of the material."

There is one drawback to the system that the researchers investigated: While a lot of charge will move into the channel between materials with a slight change in voltage, it moves slowly -- much too slowly for the type of high-frequency switching that takes place in computer chips. That could be because the samples of the material are, as Ashoori says, "super dirty"; purer samples might exhibit less electrical resistance. But it's also possible that, if researchers can understand the physical phenomena underlying the material's remarkable capacitance, they may be able to reproduce them in more practical materials.

Triscone cautions that wholesale changes to the way computer chips are manufactured will inevitably face resistance. "So much money has been injected into the semiconductor industry for decades that to do something new, you need a really disruptive technology," he says.

"It's not going to revolutionize electronics tomorrow," Ashoori agrees. "But this mechanism exists, and once we know it exists, if we can understand what it is, we can try to engineer it."

Story Source:

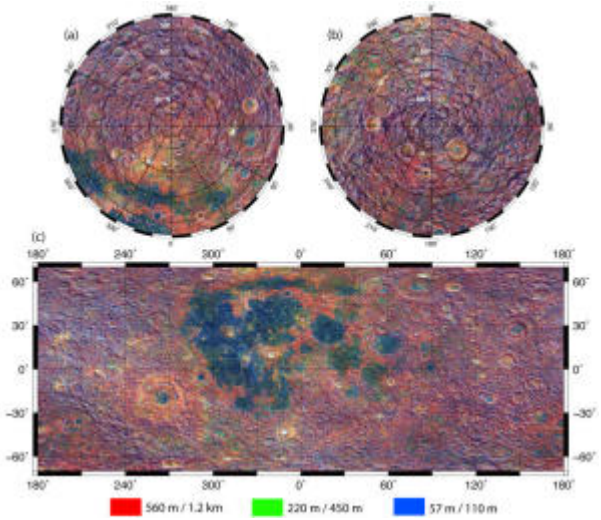
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Massachusetts Institute of Technology**. The original article was written by Larry Hardesty, MIT News Office.

Journal Reference:

1. L. Li, C. Richter, S. Paetel, T. Kopp, J. Mannhart, R. C. Ashoori. **Very Large Capacitance Enhancement in a Two-Dimensional Electron System**. *Science*, 2011; 332 (6031): 825 DOI: 10.1126/science.1204168

http://www.sciencedaily.com/releases/2011/05/110513204412.htm

Moon's Rough 'Wrinkles' Reveal Clues to Its Past



The colors in this image reveal information about the slope and roughness of the moon's surface. The slope of the surface depends on the spatial scale over which we choose to measure it, and the roughness is related to the slope. Here, the red channel shows slopes at the largest scale (half a kilometer or about one-third mile), green in between, and blue at the shortest scale (about 50 meters or 165 feet). By looking at three scales simultaneously, researchers can identify features of interest, such as the maria, which are smooth at large scales and rough at short scales; these features appear blue. The rough terrain of relatively young craters appears white, while basin ejecta--material thrown out of the large craters at the time of impact--has an orange color, meaning that this material is rougher at the large scale than at the small scale. The map is adapted from the Journal of Geophysical Research (2011). (Credit: Image courtesy of NASA/Goddard Space Flight Center)

ScienceDaily (May 15, 2011) — Written on the moon's weary face are the damages it has endured for the past 4-1/2 billion years. From impact craters to the dark plains of maria left behind by volcanic eruptions, the scars are all that remain to tell the tale of what happened to the moon. But they only hint at the processes that once acted -- and act today -- to shape the surface.

To get more insight into those processes, Meg Rosenburg and her colleagues at the California Institute of Technology, Pasadena, Calif. put together the first comprehensive set of maps revealing the slopes and roughness of the moon's surface. These maps are based on detailed data collected by the Lunar Orbiter Laser Altimeter (LOLA) on NASA's Lunar Reconnaissance Orbiter. LOLA and LRO were built at NASA's Goddard Space Flight Center in Greenbelt, Md.

Like wrinkles on skin, the roughness of craters and other features on the moon's surface can reveal their age. "The key is to look at the roughness at both long and short scales," says Rosenburg, who is the first author on the paper describing the results, published in the Journal of Geophysical Research earlier this year.

The roughness depends on the subtle ups and downs of the landscape, a quality that the researchers get at by measuring the slope at locations all over the surface. To put together a complete picture, the researchers looked at roughness at a range of different scales -- the distances between two points -- from 17 meters (about 56 feet) to as much as 2.7 kilometers (about 1.6 miles).

"Old and young craters have different roughness properties -- they are rougher on some scales and smoother on others," says Rosenburg. That's because the older craters have been pummeled for eons by meteorites that pit and mar the site of the original impact, changing the original shape of the crater.

"Because this softening of the terrain hasn't happened at the new impact sites, the youngest craters immediately stand out," says NASA Goddard's Gregory Neumann, a co-investigator on LOLA.

"It is remarkable that the moon exhibits a great range of topographic character: on the extremes, surfaces roughened by the accumulation of craters over billions of years can be near regions smoothed and resurfaced by more recent mare volcanism," says Oded Aharonson, Rosenburg's advisor at the California Institute of Technology.

By looking at where and how the roughness changes, the researchers can get important clues about the processes that shaped the moon. A roughness map of the material surrounding Orientale basin, for example, reveals subtle differences in the ejecta, or debris, that was thrown out when the crater was formed by a giant object slamming into the moon.

That information can be combined with a contour map that shows where the high and low points are. "By looking at both together, we can say that one part of Orientale is not just higher or lower, it's also differently rough," Rosenburg says. "That gives us some clues about the impact process that launched the ejecta and also about the surface processes that later acted to modify it."

Likewise, the smooth plains of maria, which were created by volcanic activity, have a different roughness "signature" from the moon's highlands, reflecting the vastly different origins of the two terrains. Maria is Latin for "seas," and they got that name from early astronomers who mistook them for actual seas.

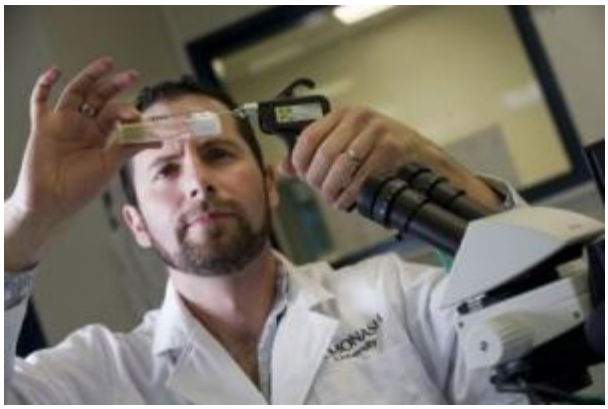
Just as on the moon, the same approach can be used to study surface processes on other bodies as well, Rosenburg says. "The processes at work are different on Mars than they are on an asteroid, but they each leave a signature in the topography for us to interpret. By studying roughness at different scales, we can begin to understand how our nearest neighbors came to look the way they do."

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/2011/05/110513204421.htm

Research Breakthrough on Male Infertility: Small Set of Genes in Cells' Mitochondria Are Key



ARC Australian Research Fellow Monash Fellow Dr. Damian Dowling (Credit: Image courtesy of Monash University)

ScienceDaily (May 15, 2011) — Around one in 20 men is infertile, but despite the best efforts of scientists, in many cases the underlying causes of infertility have remained a mystery. New findings by a team of Australian and Swedish researchers, however, will go a long way towards explaining this mystery.

According to their research published in *Science*, a small set of genes located within the power-plants of our cells -- the mitochondria -- are crucial to unravelling the secrets of male infertility.

Most of our genes are subjected to a rigorous quality-control process that prevents harmful mutations from freely accumulating within the gene pools of most species. If nasty mutations appear, then the individuals that harbor these mutations tend to do very poorly when it comes to reproducing and surviving, and hence these mutations are kept at low levels within the general population.

But while this vital screening process works well for most of our genes, it is prone to breaking down in the set of genes housed inside of the mitochondria.

Lead researcher, Dr Damian Dowling explains that mitochondrial genes are unusual because they are passed only from mother to child.

"This seemingly trivial fact actually has an enormous consequence for males. It means that mutations in the mitochondria can slip through the quality-control checks unnoticed and therefore build up to high levels, if these mutations are harmful in their effects on males but not on females. This is because all of the screening of mitochondrial mutations is done in females as a result of their maternal inheritance," Dr Dowling said.

Dr Dowling and research colleagues Paolo Innocenti and Ted Morrow of Uppsala University, Sweden, have presented compelling evidence for this process in action in the common fruit fly.

Their studies show that the particular set of mitochondrial genes an individual harbours has major effects on the expression of about 10 per cent of all the other genes inside of males, but virtually no effect on females.

Crucially, the genes that are most affected in males are expressed almost exclusively in the male reproductive organs and associated with male fertility.

"What our results suggest is that the mitochondria have inadvertently evolved to be bad for males, but good for females, as a by-product of their maternal transmission. This might well put the sexes in conflict when it comes to the question of which mitochondrial genes should be passed on to future generations," Dr Dowling said.

"While medical practitioners have a fairly good idea that certain mitochondrial mutations can bring about male infertility, the evolutionary process that we uncover actually suggests that the mitochondria might well harbor very many unidentified mutations, all of which could contribute to the problem of male infertility.

"At the very least, our results should therefore provide a road-map of where we should be looking for these mutations."

Story Source:

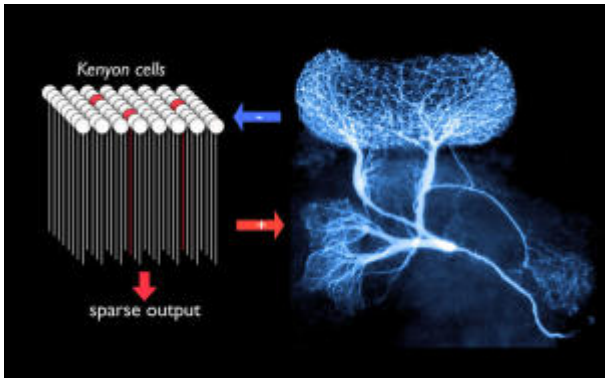
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Monash University**.

Journal Reference:

1. P. Innocenti, E. H. Morrow, D. K. Dowling. **Experimental Evidence Supports a Sex-Specific Selective Sieve in Mitochondrial Genome Evolution**. *Science*, 2011; 332 (6031): 845 DOI: 10.1126/science.1201157

http://www.sciencedaily.com/releases/2011/05/110513112258.htm

Sense of Smell: Single Giant Interneuron in Locusts Controls Activity in 50,000 Neurons, Enabling Sparse Codes for Odours



A single "giant", non-spiking, GABAergic interneuron (right, labelled by intracellular injection of fluorescent dye) forms an all-to-all negative feedback loop with a population of about 50,000 Kenyon cells, principal neurons of the mushroom bodies, a structure involved in olfactory memory in the insect brain. This normalizing feedback loop serves to ensure relatively constant sparseness of mushroom body output across varying input strengths. Sparseness is an important feature of sensory representations in areas involved in memory formation. (Credit: © MPI for Brain Research)

ScienceDaily (May 14, 2011) — The brain is a coding machine: it translates physical inputs from the world into visual, olfactory, auditory, tactile perceptions via the mysterious language of its nerve cells and the networks which they form. Neural codes could in principle take many forms, but in regions forming bottlenecks for information flow (e.g., the optic nerve) or in areas important for memory, sparse codes are highly desirable.

Scientists at the Max Planck Institute for Brain Research in Frankfurt have now discovered a single neuron in the brain of locusts that enables the adaptive regulation of sparseness in olfactory codes. This single giant interneuron tracks in real time the activity of several tens of thousands of neurons in an olfactory centre and feeds inhibition back onto all of them, so as to maintain their collective output within an appropriately sparse regime. In this way, representation sparseness remains steady as input intensity or complexity varies.

Signals from the world (electromagnetic waves, pressure, chemicals etc) are converted to electrical activity in sensory neurons and processed by neuronal networks in the brain. Insects sense smells via their antennae. Odours are detected by sensory neurons there, and olfactory data are then sent to and processed by the antennal lobes and a region of the brain known as the mushroom bodies. Neurons in the antennal lobes tend to be "promiscuous": odours are thus represented by specific combinations of neuronal activity. Neurons in the mushroom bodies -- they are called Kenyon cells -- , however, respond with great specificity and thus extremely rarely. In addition, they generally respond with fewer than three electrical impulses when stimulated with the right odour. This "sparse coding" strategy has the advantage that it simplifies the task of storing odour representations in memory.

Surprisingly, each Kenyon cell is connected on average to half of all possible presynaptic neurons in the antennal lobes. So how do the Kenyon cells manage to respond only extremely rarely, and with a sparseness that varies little over large ranges of stimulation conditions? Gilles Laurent of the Max Planck Institute for Brain Research and his group found that a single giant interneuron plays a key role. Along with colleagues in his lab (formerly at Caltech) and Great Britain, he has discovered that this neuron, with its extensive arbour, is activated by the entire Kenyon cell population and in turn inhibits them all back. "The giant interneuron and the Kenyon cells form a simple negative feed-back loop: the more strongly it is activated by the Kenyon cell population, the more strongly it curtails their activity in return," explains Laurent. The interneuron itself does

not generate any action potentials, but inhibits Kenyon cells via nonspiking and graded release of the neurotransmitter GABA (gamma aminobutyric acid). This smooth, graded property enables this giant interneuron to do a kind of real-time, population averaging, thus carrying out an operation that might otherwise require the involvement of hundreds or thousands of individual spiking neurons.

The effectiveness of the giant interneuron is such that it can actually turn off the Kenyon cell population completely. But the research team also discovered that the giant interneuron is, in turn, controlled by another inhibitory neuron. "This allows the network activity to be potentiated or attenuated, and the sensitivity of this feedback loop to be adjusted," says Gilles Laurent. This is an important feature for brain regions such as the mushroom bodies, which are responsible not only for olfactory processing, but also for learning and memory. Mushroom bodies are where smells can be associated with other sensory modalities, enabling the formation of complex representations.

The scientists' findings show how massive negative feed-back loops can be formed in neuronal networks and what roles they can play. In vertebrates, the piriform cortex, part of the olfactory cortical complex, sits in a position equivalent to the mushroom bodies. "It is very likely that mammals have similar all-to-all control mechanisms in cortical and other circuits. They might not consist of single interneurons, however, but rather of populations of inhibitory neurons with means to couple their responses and actions," surmises Laurent. "Insect brains never cease to give us insights about neural computation, and to put elegant solutions right on our laps, if we know where to look and are a bit lucky."

Story Source:

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

Journal Reference:

1. M. Papadopoulou, S. Cassenaer, T. Nowotny, G. Laurent. **Normalization for Sparse Encoding of Odors by a Wide-Field Interneuron**. *Science*, 2011; 332 (6030): 721 DOI: 10.1126/science.1201835

http://www.sciencedaily.com/releases/2011/05/110513112248.htm

The Kitchen-Table Industrialists

By ANAND GIRIDHARADAS

Brian Finke for The New York Times

Hands On Ayah Bdeir, the founder and, more significant, creator of littleBits.

Late in 2007, Ayah Bdeir was working in a plush office in Midtown Manhattan, making a lot of money and feeling miserable. She was a financial-software consultant for a technology company. One of her specialties was peddling software for credit-default swaps — among the many complex financial instruments that would soon wreak havoc on the planet. Somewhere there was a thing from which these derivatives were derived, but Bdeir, atop countless layers of transacting, was too far away to see it, much less touch it.

Bdeir is 28, a petite and round-faced woman, gregarious and combustible. As she describes it now, the virtuality of her working life was deeply upsetting; she felt surrounded by the inconsequential, the endless conversation about how to display the nominal on PowerPoints that called for the making of future PowerPoints. Just before year's end, Bdeir quit. She secured a fellowship, for considerably lower pay, from an art and technology center in Chelsea. She knew that she wanted her next project to be the opposite of a credit-default swap — tangible, constructive. And then it hit her: the opposite of her make-believe transacting would be to make things. A few years earlier, as a graduate student at the M.I.T. Media Lab, she fell in with a community that was trying to transform manufacturing — a new kind of small-scale, local manufacturing that could be done in the home, with machines no bigger than a microwave. Bdeir now resolved, over the strenuous objection of her mother and several friends, to become a new-age manufacturer.

At first, she pursued the idea as a financial-industry software executive might: she researched making, made plans to make and made PowerPoints about making. Meanwhile, she made nothing. Then, while earning some money by training not-very-tech-savvy designers in the use of electronics, Bdeir had the idea, in collaboration with a colleague, of making electronics components into Lego-like bricks that could be used by anybody, even the technically ungifted. She would make sets of self-contained bricks, filled with circuits, sensors, solar panels and motors that could be snapped together to create basic machines — for instance, a battery

connected to a bulb and a pressure sensor that can illuminate or dim it. She would make things and allow others to make other things.

She would eventually turn the brick project into a business, selling $99 kits, called littleBits, for people to make their own crude gadgets. She wagered her career on the belief that in her resistance to the virtual, in her longing to make something actual, she was not alone.

And she wasn't. Even as one boom era hurtled toward its end, a diffuse global community of nerds was at work on what it hoped would fuel the next one. They were coming to the same conclusion as Ayah Bdeir — that the new new thing was, in fact, things.

If you lived in Detroit in 1961 and watched Alfred Hitchcock's "Psycho" at a drive-in, you might have caught a 30-minute trailer called "American Maker," sponsored by Chevrolet. "Of all things Americans are, we are makers," its narrator began, over footage of boys building sand castles. "With our strengths and our minds and spirit, we gather, we form and we fashion: makers and shapers and put-it-togetherers."

Fifty years on, the American maker is in a bad way. Such is the state of American industry that waste paper is among the top 10 exports to China, behind nuclear equipment but far ahead of traditional mainstays like iron and steel. Manufacturing employment has fallen by a third in the last decade alone, with more than 40,000 factories shutting down. More Americans today are unemployed than are wage-earning "put-it-togetherers." But the American romance with making actual things is going through a resurgence. In recent years, a nationwide movement of do-it-yourself aficionados has embraced the self-made object. Within this group is a quixotic band of soldering, laser-cutting, software-programming types who, defying all economic logic, contend that they can reverse America's manufacturing slump. America will make things again, they say, because *Americans* will make things — not just in factories but also in their own homes, and not because it's artisanal or faddish but because it's easier, better for the environment and more fun.

What makes this notion something less than complete fantasy is the availability of new manufacturing machines that are cheap, simple and compact enough for small companies, local associations and even amateur hobbyists to own and operate. What once only big firms with hulking factories could fabricate can now be made in a basement or by e-mailing a design to an online factory-for-hire. These machines can produce all sorts of things, including plastic pencil holders, eyeglass frames and MP3 players.

Makers, as they call themselves, can't compete with the long, orderly rows of workers from the poorer provinces of China or India who cut, stitch and solder bras, shoes and cellphones for pennies — or even with the hundreds of billions of dollars a year worth of stuff that continues to pour out of large, old-fashioned American factories. Their method involves creating "hacker space" cooperatives, where a few dozen members share a 3-D printer, a laser cutter and an oscilloscope and engage in collaborative manufacturing projects. Makers have created companies like Shapeways and CloudFab, which for a fee will manufacture small runs of products that you design. They are becoming kit makers like Bdeir, manufacturing building blocks that allow others to create things.

Neil Gershenfeld, an M.I.T. physicist who is an intellectual godfather to the maker movement, suggested to me that the new tools would over time change global industry as we know it. He predicts a wave of new competitors for the megacorporation that designs, makes and sells products all under one brand. Instead, Gershenfeld imagines a consumer of the near future downloading a design for a mobile phone through an iTunes-like portal; buying an add-on from another firm that tweaks the design; and having it printed at a neighborhood shop in a plastic shell of your choice.

The new personal factories may seem like crude toys for only the most die-hard D.I.Y.-ers. But in technology circles, they are talked about as a looming revolution that could change the way people work and create new opportunities for millions. Personal factories can perhaps be compared to the earliest personal computers —

versions of their giant counterparts that are drastically cheaper but also slower and more clumsy. This futuristic vision is the one that the White House endorsed in a recent report on personal manufacturing: "Within a generation, you will have a hard time explaining to your grandchildren how you were able to live without your own fabber," it said, using a popular word for the new manufacturing tools. "Personal-fabrication technologies present an opportunity for our nation to continue to lead the rest of the world in manufacturing, but in a new way."

Brian Finke for The New York Times

Build-a-Brother Andrew, seated, and Ted Sliwinski in their Detroit workshop

Before they could create their own little manufacturing hub in Detroit, Andrew and Ted Sliwinski and their associates had to cleanse their industrial space of the stench of meat. Bucket after bucket of hydrogen peroxide and bleach helped to turn a former cold-storage warehouse in the Eastern Market of Detroit into a D.I.Y. manufacturing cooperative.

The Sliwinski brothers came to Detroit from the suburbs of Philadelphia with the romantic notion of partaking in a revival of the city's tradition of making things. They and their colleagues rent the 7,200-square-foot warehouse, where more than two dozen members of the cooperative share laser cutters, 3-D printers, plastic vacuums and power drills. The ground floor holds the more basic appliances — drills and saws and such. Once a week, they open up the space, named OmniCorpDetroit, to the public for an "open hack night" — something that many cooperatives do. (Since our meeting, Andrew decided to move again, to California, where he plans to establish a new hacker space.)

Andrew and Ted have their desks upstairs, where the fancier work is done: there are electronics-making stations, with oscilloscopes and other tools; a community sewing center with machines that do complex embroidery; there is MakerBot Industries' CupCake CNC, a so-called 3-D printer that spits out small plastic wares. Makers describe it as the IBM PC of personal factories — at $699 and sold in kits for assembly at home, it is the democratizing technology.

When I was there, I felt an urge to make something of my own. Andrew volunteered to help. He is 28 and slender, with a thick, rust-hued beard. He was wearing a wool hat, thick-framed plastic glasses, a black hoodie and black jeans, giving him more the look of know-it-all record-store clerk than of manufacturing champion. But the man knew what he was doing. He guided me to the Web site Thingiverse.com, which abounds in digital models — three-dimensional files that the CupCake can print out. I browsed and chose an iPad stand.

I downloaded the files, and the computer processed them. The CupCake is a wood box, about the size of a blender, with open windows on three sides. The fourth side is covered with a rainbow thicket of wires and circuits; a spool of black plastic coil, which is melted to create the final object, poked in through the roof. As we instructed the computer to print, Andrew warned,"Oh, yeah, and it will start to smell like burning plastic."

Which it soon did. The CupCake began to print. First the nozzle moved back and forth smoothly, dropping black plastic in neat rows. It was building a base for my object. Then it began to jitterbug, dashing unpredictably this way and that, depositing bits of the melting goo one layer at a time. Slowly it formed an iPad stand. But then, 19 minutes in, the machine lost the plot and began to squirt everywhere, and we had to start over.

We raised the melting temperature and tried again. Failure once more. Andrew tinkered with the machine and repeatedly muttered, "It's not superhappy right now." It was hard not to wonder whether it wouldn't be easier just to have the Chinese do it.

Andrew said that the design I picked might have been flawed. We decided to try something easier: a hexagonal nut. At last, in less than half an hour, we had our perfect little nut. It was simple, unambitious and wonderful, though it might have been quicker to get it at a hardware store.

At the end of a long day, I accompanied a handful of makers to dinner at the nearby Cass Cafe. It was full of students and the artsy types now trickling into the city. Detroiters have various levels of appreciation and contempt for these outsiders, with their taste for all things free-range, open-source and wiki. OmniCorp fits well into this mix, because for its members and others in the maker community, manufacturing is about more than economic renewal; it is also about pushing back against the passivity that technology has bred, about being a smart consumer who knows what goes into your stuff. Making, for some, is a new liberal virtue. Andrew told me one day: "There is something calming or reassuring or relaxing that happens when you build something with your hands. You've just made something bigger than yourself. You're not just being a consumer anymore."

When Limor Fried and Phillip Torrone went office hunting in New York and found the perfect loft five blocks from Wall Street, they ran into two peculiar requirements from the landlord: they could rent the place if they had nothing to do with hedge funds and investment banks and if they could produce bank statements showing that their rent money was kept in such banalities as savings accounts, not in derivatives or futures. The landlord learned a lesson from the previous tenant, a trader who vacated when Wall Street collapsed.

The landlord was sufficiently reassured by the nature of the business, which is to do in a $6,000-a-month Manhattan apartment what the conventional wisdom says can profitably be done only in Shenzhen. Their company, Adafruit Industries, sells do-it-yourself electronics kits, which they manufacture and ship so that you, in turn, can make your own crude iPod equivalent or bespoke baby monitor or D.I.Y. phone charger. They are regarded as trailblazers among their fellow makers, because they actually manufacture in Manhattan and profitably. According to Torrone, the company had $2 million in sales in 2009, up from $60,000 in 2005, its first year.

In Adafruit's spacious loft, seven full-time employees, Torrone and Fried, the engineer-founder who owns the company, labor away on the kits. The full-timers are paid more than $50,000 a year and receive health benefits. I asked Torrone, the creative director, how it was possible to compensate these employees and create physical things profitably in Manhattan. He told me that making things right where they are invented allows Adafruit to build, test and perfect new products more swiftly. The higher price of rent and labor are balanced by a reduction in shipping bills, so that the costs are manageable. One of the company's best-selling kits, for a battery-powered cellphone charger, costs Adafruit $6 in parts and labor, Torrone said, and is sold to retailers for roughly $12. Moreover, he said, being in New York gives the company access to creativity and talent that is worth paying for.

"It would be cheaper if we were in the middle of nowhere," Torrone told me, "but we'd be stuck in the middle of nowhere."

Adafruit also illustrates how a good part of this new manufacturing operates through open-source sharing and what can be called social tinkering, in contrast with the manufacturing of the past, which emphasized patents, trade secrets and proprietary invention. Fried got the idea for such a company when, as a graduate student at the M.I.T. Media Lab, she began making simple MP3 players and cellphone jammers, just for nerdy kicks, and made the recipes for her creations — CAD files, software, mechanical drawings — public on her blog. Requests poured in for kits that would allow people to make what she designed, and Adafruit was born.

Today Adafruit remains an open-source company. It publicizes how its kits are made, so that you can clone them, and also reveals how it runs as a business. The company says which Internet service provider it uses, which shipping company, which software runs its online shopping system. Torrone told me that they share this information so that other companies, including rivals, can cut to the chase of genuine discovery and not get bogged down reinventing wheels.

At Adafruit, I did some quality-assurance work, which seemed a good way of understanding what the company did. I tested 40 circuit boards by pressing them against a set of pins. Thirty-seven passed. I placed each board in a pink bag and heat-sealed it. Later, I ran checks on bagged kits to find which of three clear light bulbs mistakenly shone yellow when electrified.

It was surreal to do this assembly-line work in Lower Manhattan. It felt like a violation of the economic laws of nature. The tasks were at once mindless and engaging. They required focus, because if you were distracted for a minute, you would mess up and your error would ramify into the world. But it also felt as if it could get old fairly quickly. The most invigorating part was that I didn't think about e-mail, my phone or Twitter while I was making. I was, against all modern odds, indivisibly present.

It was that very feeling that Ayah Bdeir craved after leaving the world of finance. When that world tumbled into full-fledged crisis at the end of 2008, pangs of guilt shot through her. It was her swaps that had done this. "I was shocked, and I felt bad, because somehow I was contributing to this injustice, and I had no idea," she told me. "I felt guilty for a while. I have three degrees; I speak three languages; I pride myself on my scientific and mathematical thinking — how could I not have understood the social, economic and political dimensions of something that I was working on that ended up ruining the world?"

She has now found peace in her littleBits. On my trip to New York, I was able to play with her prototype kit. (The real ones, a first batch of 300, will be shipped to customers this spring.) The little Lego-like bricks snapped together magnetically and repelled one another when you put them the wrong way, which prevents electric shocks or unintentional meltdowns. The kit is simple enough for children to play with. But Bdeir keeps a black notebook of ideas for future bricks that she hopes will allow customers to make more-complex machines.

She told me that when she received the packaging for her prototype and finally had the total kit in hand, as it would come to customers, she sent her family an e-mail: "LittleBits exists in the world because of me." It was the heralding of the new and a last swipe at her own past: she now could boast of a real and tangible contribution — something that *was* because she made it.

Anand Giridharadas (a@anand.ly) is an online columnist for The Times and the author of "India Calling: An Intimate Portrait of a Nation's Remaking." Editor: Ilena Silverman (i.silverman-maggroup@nytimes.com).

http://www.nytimes.com/2011/05/15/magazine/the-kitchen-table-industrialists.html?ref=magazine

New Calculations on Blackbody Energy Set the Stage for Clocks With Unprecedented Accuracy

Physicists have developed a means for computing, with unprecedented accuracy, a tiny, temperature-dependent source of error in atomic clocks. (Credit: © -Misha / Fotolia)

ScienceDaily (May 14, 2011) — A team of physicists from the United States and Russia announced that it has developed a means for computing, with unprecedented accuracy, a tiny, temperature-dependent source of error in atomic clocks. Although small, the correction could represent a big step towards atomic timekeepers' longstanding goal of a clock with a precision equivalent to one second of error every 32 billion years -- longer than the age of the universe.

Precision timekeeping is one of the bedrock technologies of modern science and technology. It underpins precise navigation on Earth and in deep space, synchronization of broadband data streams, precision measurements of motion, forces and fields, and tests of the constancy of the laws of nature over time.

"Using our calculations, researchers can account for a subtle effect that is one of the largest contributors to error in modern atomic timekeeping," says lead author Marianna Safronova of the University of Delaware, the first author of the presentation. "We hope that our work will further improve upon what is already the most accurate measurement in science: the frequency of the aluminum quantum-logic clock," adds co-author Charles Clark, a physicist at the Joint Quantum Institute, a collaboration of the National Institute of Standards and Technology (NIST) and the University of Maryland.

The paper was presented at the 2011 Conference on Lasers and Electro-Optics in Baltimore, Md.

The team studied an effect that is familiar to anyone who has basked in the warmth of a campfire: heat radiation. Any object at any temperature, whether the walls of a room, a person, the Sun or a hypothetical perfect radiant heat source known as a "black body," emits heat radiation. Even a completely isolated atom senses the temperature of its environment. Just as heat swells the air in a hot-air balloon, so-called "blackbody radiation" (BBR) enlarges the size of the electron clouds within the atom, though to a much lesser degree -- by one part in a hundred trillion, a size that poses a severe challenge to precision measurement.

This effect comes into play in the world's most precise atomic clock, recently built by NIST researchers. This quantum-logic clock, based on atomic energy levels in the aluminum ion, Al+, has an uncertainty of 1 second per 3.7 billion years, translating to 1 part in 8.6 x 10-18, due to a number of small effects that shift the actual tick rate of the clock.

To correct for the BBR shift, the team used the quantum theory of atomic structure to calculate the BBR shift of the atomic energy levels of the aluminum ion. To gain confidence in their method, they successfully reproduced the energy levels of the aluminum ion, and also compared their results against a predicted BBR shift in a strontium ion clock recently built in the United Kingdom. Their calculation reduces the relative uncertainty due to room-temperature BBR in the aluminum ion to 4 x 10^{-19}, or better than 18 decimal places, and a factor of 7 better than previous BBR calculations.

Current aluminum-ion clocks have larger sources of uncertainty than the BBR effect, but next-generation aluminum clocks are expected to greatly reduce those larger uncertainties and benefit substantially from better knowledge of the BBR shift.

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)**.

---

http://www.sciencedaily.com/releases/2011/05/110511162528.htm

Artificial Grammar Reveals Inborn Language Sense, Study Shows

A new study by cognitive scientists confirms that human beings are born with knowledge of certain syntactical rules that make learning human languages easier. (Credit: iStockphoto/Felix Manuel Burgos-Trujillo)

ScienceDaily (May 13, 2011) — Parents know the unparalleled joy and wonder of hearing a beloved child's first words turn quickly into whole sentences and then babbling paragraphs. But how human children acquire language -- which is so complex and has so many variations -- remains largely a mystery. Fifty years ago, linguist and philosopher Noam Chomsky proposed an answer: Humans are able to learn language so quickly because some knowledge of grammar is hardwired into our brains. In other words, we know some of the most fundamental things about human language unconsciously at birth, without ever being taught.

Now, in a groundbreaking study, cognitive scientists at The Johns Hopkins University have confirmed a striking prediction of the controversial hypothesis that human beings are born with knowledge of certain syntactical rules that make learning human languages easier.

"This research shows clearly that learners are not blank slates; rather, their inherent biases, or preferences, influence what they will learn. Understanding how language is acquired is really the holy grail in linguistics," said lead author Jennifer Culbertson, who worked as a doctoral student in Johns Hopkins' Krieger School of Arts and Sciences under the guidance of Geraldine Legendre, a professor in the Department of Cognitive Science, and Paul Smolensky, a Krieger-Eisenhower Professor in the same department. (Culbertson is now a postdoctoral fellow at the University of Rochester.)

The study not only provides evidence remarkably consistent with Chomsky's hypothesis but also introduces an interesting new approach to generating and testing other hypotheses aimed at answering some of the biggest questions concerning the language learning process.

In the study, a small, green, cartoonish "alien informant" named Glermi taught participants, all of whom were English-speaking adults, an artificial nanolanguage named Verblog via a video game interface. In one experiment, for instance, Glermi displayed an unusual-looking blue alien object called a "slergena" on the screen and instructed the participants to say "geej slergena," which in Verblog means "blue slergena." Then participants saw three of those objects on the screen and were instructed to say "slergena glawb," which means "slergenas three."

Although the participants may not have consciously known this, many of the world's languages use both of those word orders-that is, in many languages adjectives precede nouns, and in many nouns are followed by numerals. However, very rarely are both of these rules used together in the same human language, as they are in Verblog.

As a control, other groups were taught different made-up languages that matched Verblog in every way but used word order combinations that are commonly found in human languages.

Culbertson reasoned that if knowledge of certain properties of human grammars-such as where adjectives, nouns and numerals should occur-is hardwired into the human brain from birth, the participants tasked with learning alien Verblog would have a particularly difficult time, which is exactly what happened.

The adult learners who had had little to no exposure to languages with word orders different from those in English quite easily learned the artificial languages that had word orders commonly found in the world's languages but failed to learn Verblog. It was clear that the learners' brains "knew" in some sense that the Verblog word order was extremely unlikely, just as predicted by Chomsky a half-century ago.

The results are important for several reasons, according to Culbertson.

"Language is something that sets us apart from other species, and if we understand how children are able to quickly and efficiently learn language, despite its daunting complexity, then we will have gained fundamental knowledge about this unique faculty," she said. "What this study suggests is that the problem of acquisition is made simpler by the fact that learners already know some important things about human languages-in this case, that certain words orders are likely to occur and others are not."

This study was done with the support of a $3.2 million National Science Foundation grant called the Integrative Graduate Education and Research Traineeship grant, or IGERT, a unique initiative aimed at training doctoral students to tackle investigations from a multidisciplinary perspective.

According to Smolensky, the goal of the IGERT program in Johns Hopkins' Cognitive Science Department is to overcome barriers that have long separated the way that different disciplines have tackled language research.

"Using this grant, we are training a generation of interdisciplinary language researchers who can bring together the now widely separated and often divergent bodies of research on language conducted from the perspectives of engineering, psychology and various types of linguistics," said Smolensky, principal investigator for the department's IGERT program.

Culbertson used tools from experimental psychology, cognitive science, linguistics and mathematics in designing and carrying out her study.

"The graduate training I received through the IGERT program at Johns Hopkins allowed me to synthesize ideas and approaches from a broad range of fields in order to develop a novel approach to a really classic question in the language sciences," she said.

Story Source:

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

http://www.sciencedaily.com/releases/2011/05/110513112256.htm

Researchers Identify DNA Region Linked to Depression

ScienceDaily (May 15, 2011) — Researchers at Washington University School of Medicine in St. Louis and King's College London have independently identified DNA on chromosome 3 that appears to be related to depression.

Major depression affects approximately 20 percent of people at some point during their lives, and family studies have long suggested that depression risk is influenced by genetics. The new studies identify a DNA region containing up to 90 genes. Both are published May 16 in the *American Journal of Psychiatry.*

"What's remarkable is that both groups found exactly the same region in two separate studies," says senior investigator Pamela A. F. Madden, PhD, professor of psychiatry at Washington University. "We were working independently and not collaborating on any level, but as we looked for ways to replicate our findings, the group in London contacted us to say, 'We have the same linkage peak, and it's significant.'"

Madden and the other researchers believe it is likely that many genes are involved in depression. While the new findings won't benefit patients immediately, the discovery is an important step toward understanding what may be happening at the genetic and molecular levels, she says.

The group at King's College London followed more than 800 families in the United Kingdom affected by recurrent depression. The Washington University group gathered data from 91 families in Australia and another 25 families in Finland. At least two siblings in each family had a history of depression, but the Australian and Finnish participants were studied originally because they were heavy smokers.

"Major depression is more common in smokers, with lifetime reports as high as 60 percent in smokers seeking treatment," says lead author Michele L. Pergadia, PhD, research assistant professor of psychiatry at Washington University. "Smokers with depression tend to experience more nicotine withdrawal and may be more likely to relapse when trying to quit. Previous studies suggest that smoking and depression run together in families. In our study, we detected a region of the genome that travels with depression in families of smokers."

Meanwhile, the group in England was concerned primarily with recurrent depression. Although some of the families in the King's College London survey may have included heavy smokers, the researchers were primarily interested in people who were depressed.

"These findings are truly exciting," says Gerome Breen, PhD, lead author of the King's College London study. "For the first time, we have found a genetic region associated with depression, and what makes the findings striking is the similarity of the results between our studies."

From two different data sets, gathered for different purposes and studied in different ways, the research teams found what is known as a linkage peak on chromosome 3. That means that the depressed siblings in the families in both studies carried many of the same genetic variations in that particular DNA region.

Unlike many genetic findings, this particular DNA region has genome-wide significance. Often when researchers correct statistically for looking across the entire genome, what appeared originally to be significant becomes much less so. That was not the case with these studies.

Although neither team has isolated a gene, or genes, that may contribute to depression risk, the linkage peak is located on a part of the chromosome known to house the metabotropic glutamate receptor 7 gene (GRM7). Some other investigators have found suggestive associations between parts of GRM7 and major depression.

"Our linkage findings highlight a broad area," Pergadia says. "I think we're just beginning to make our way through the maze of influences on depression. The U.K. samples came from families known to be affected by depression. Our samples came from heavy smokers, so one thing we might do as we move forward is try to better characterize these families, to learn more about their smoking and depression histories, in addition to all of their genetic information in this area."

Pergadia says it may be worthwhile to start by combining the data sets from the two studies to see whether this region of chromosome 3 continues to exert a significant effect.

Although there is still work to do, the new studies are a very important step on the road to understanding how genes influence depression, according to Peter McGuffin, MB, PhD, director of the Medical Research Council Social, Genetic and Developmental Psychiatry Centre at King's College London.

"The findings are groundbreaking," says McGuffin, senior author of that study. "However, they still only account for a small proportion of the genetic risk for depression. More and larger studies will be required to find the other parts of the genome involved."

This work was supported by grants from the National Institutes of Health (NIH); the National Institute for Health and Welfare, Helsinki, Finland; the Institute for Molecular Medicine, Finland; the Queensland Institute of Medical Research, Brisbane, Australia.

Story Source:

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

Journal References:

1. M. L. Pergadia, A. L. Glowinski, N. R. Wray, A. Agrawal, S. F. Saccone, A. Loukola, U. Broms, T. Korhonen, B. W. J. H. Penninx, J. D. Grant, E. C. Nelson, A. K. Henders, A. J. Schrage, Y.-L. Chou, K. Keskitalo-Vuokko, Q. Zhu, S. D. Gordon, J. M. Vink, E. J. C. de Geus, S. MacGregor, J. Z. Liu, G. Willemsen, S. E. Medland, D. I. Boomsma, G. W. Montgomery, J. P. Rice, A. M. Goate, A. C. Heath, J. Kaprio, N. G. Martin, P. A. F. Madden. **A 3p26-3p25 Genetic Linkage Finding for DSM-IV Major Depression in Heavy Smoking Families**. *American Journal of Psychiatry*, 2011; DOI: 10.1176/appi.ajp.2011.10091319
2. G. Breen, B. T. Webb, A. W. Butler, E. J. C. G. van den Oord, F. Tozzi, N. Craddock, M. Gill, A. Korszun, W. Maier, L. Middleton, O. Mors, M. J. Owen, S. Cohen-Woods, J. Perry, N. W. Galwey, R. Upmanyu, I. Craig, C. M. Lewis, M. Ng, S. Brewster, M. Preisig, M. Rietschel, L. Jones, J. Knight, J. Rice, P. Muglia, A. E. Farmer, P. McGuffin. **A Genome-Wide Significant Linkage for Severe Depression on Chromosome 3: The Depression Network Study**. *American Journal of Psychiatry*, 2011; DOI: 10.1176/appi.ajp.2011.10091342

http://www.sciencedaily.com/releases/2011/05/110515201322.htm

Next Generation Gamers: Computer Games Aid Recovery from Stroke

ScienceDaily (May 15, 2011) — Computer games are not just for kids. New research published in *Journal of NeuroEngineering and Rehabilitation*, a BioMed Central open access journal, shows that computer games can speed up and improve a patient's recovery from paralysis after a stroke.

It is often difficult for stroke victims to recover hand and arm movement, and 80-90% of sufferers still have problems six months later. Scientists in America looked at a group of people who had impaired use of one arm after a stroke and found that computer simulations and cutting edge techniques, used by the film industry to produce computer generated action, could restore lost function.

While many current training regimes concentrate on regaining hand and arm movement separately, the computer games and robotic training aids used in this trial attempted to simultaneously improve function of both together. The games Plasma Pong and Hammer Task were used to improve hand/arm coordination, accuracy and speed, while the Virtual Piano and Hummingbird Hunt simulations helped to restore precision of grip and individual finger motion.

After training for two-three hours a day for eight days, all of the patients showed increased control of hand and arm during reaching. They all had better stability of the damaged limb, and greater smoothness and efficiency of movement. Kinematic analysis showed that they also had improved control over their fingers and were quicker at all test tasks. In contrast their uninjured arm and the arms of control game players, who had normal hand/arm function, showed no significant improvement at all.

Dr Alma Merians said, "Patients who played these games showed an average improvement in their standard clinical scores of 20-22% over the eight days. These results show that computer games could be an important tool in the recovery of paralysed limbs after stroke."

Email or share this story:
| More

Story Source:

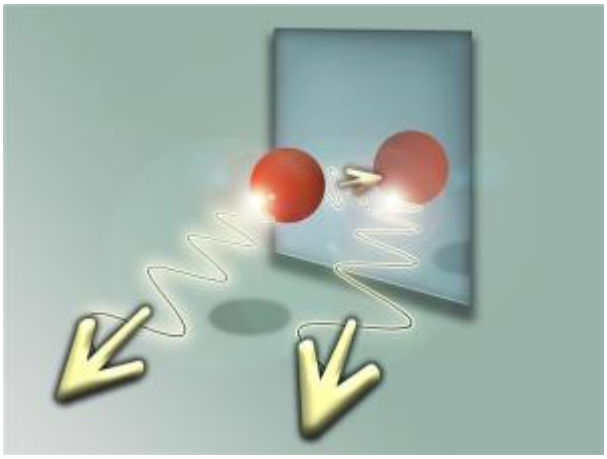
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **BioMed Central**, via EurekAlert!, a service of AAAS.

Journal Reference:

1. Alma S Merians, Gerard G Fluet, Qinyin Qiu, Soha Saleh, Ian Lafond, Amy Davidow and Sergei V Adamovich. **Robotically Facilitated Virtual Rehabilitation of Arm Transport Integrated With Finger Movement in Persons with Hemiparesis**. *Journal of NeuroEngineering and Rehabilitation*, 2011; (in press) [link]

http://www.sciencedaily.com/releases/2011/05/110515201320.htm

The Atom and Its Quantum Mirror Image: Physicists Experimentally Produces Quantum-Superpositions, Simply Using a Mirror



Towards the mirror or away from the mirror? Physicists create atoms in quantum superposition states. (Credit: Image courtesy of Vienna University of Technology)

ScienceDaily (May 16, 2011) — Standing in front of a mirror, we can easily tell apart ourselves from our mirror image. The mirror does not affect our motion in any way. For quantum particles, this is much more complicated. In a spectacular experiment in the labs of the University of Heidelberg, a group of physicists at the University Heidelberg, together with colleagues at TU Munich and TU Vienna extended a 'thought experiment' by Einstein and managed to blur the distinction between a particle and its mirror image.

The results of this experiment have now been published in the journal *Nature Physics*.

Emitted Light, Recoiling Atom

When an atom emits light (i.e. a photon) into a particular direction, it recoils in the opposite direction. If the photon is measured, the motion of the atom is known too. The scientists placed atoms very closely to a mirror. In this case, there are two possible paths for any photon travelling to the observer: it could have been emitted directly into the direction of the observer, or it could have travelled into the opposite direction and then been reflected in the mirror. If there is no way of distinguishing between these two scenarios, the motion of the atom is not determined, the atom moves in a superposition of both paths.

"If the distance between the atom and the mirror is very small, it is physically impossible to distinguish between these two paths," Jiri Tomkovic, PhD student at Heidelberg explains. The particle and its mirror image cannot be clearly separated any more. The atom moves towards the mirror and away from the mirror at the same time. This may sound paradoxical and it is certainly impossible in classical phyiscs for macroscopic objects, but in quantum physics, such superpositions are a well-known phenomenon.

"This uncertainty about the state of the atom does not mean that the measurement lacks precision," Jörg Schmiedmayer (TU Vienna) emphasizes. "It is a fundamental property of quantum physics: The particle is in both of the two possible states simultaneously, it is in a superposition." In the experiment the two motional states of the atom -- one moving towards the mirror and the other moving away from the mirror -- are then combined using Bragg diffraction from a grating made of laser light. Observing interference it can be directly shown that the atom has indeed been traveling both paths at once.

On Different Paths at the Same Time

This is reminiscent of the famous double-slit experiment, in which a particle hits a plate with two slits and passes through both slits simultaneously, due to its wave-like quantum mechanical properties. Einstein already discussed that this can only be possible if there is no way to determine which path the particle actually chose, not even precise measurements of any tiny recoil of the double slit plate itself. As soon as there even a theoretically possible way of determining the path of the particle, the quantum superposition breaks down.

"In our case, the photons play a role similar to the double slit," Markus Oberthaler (University of Heidelberg) explains. "If the light can, in principle, tell us about the motion of the atom, then the motion is unambiguously determined. Only when it is fundamentally undecidable, the atom can be in a superposition state, combining both possibilities." And this fundamental undecidability is guaranteed by the mirror which takes up the photon momentum.

Quantum Effect -- Using Only a Mirror

Probing under which conditions such quantum-superpositions can be created has become very important in quantum physics. Jörg Schmiedmayer and Markus Obertaler came up with the idea for this experiment already a few years ago. "The fascinating thing about this experiment," the scientists say, "is the possibility of creating a quantum superposition state, using only a mirror, without any external fields." In a very simple and natural way the distinction between the particle and its mirror image becomes blurred, without complicated operations carried out by the experimenter.

Story Source:

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

Journal Reference:

1. Jiří Tomkovič, Michael Schreiber, Joachim Welte, Martin Kiffner, Jörg Schmiedmayer, Markus K. Oberthaler. **Single spontaneous photon as a coherent beamsplitter for an atomic matter-wave**. *Nature Physics*, 2011; DOI: 10.1038/nphys1961

http://www.sciencedaily.com/releases/2011/04/110405084252.htm

Practice, Not Loss of Sight, Improves Sense of Touch in the Blind

The device used in the fingertips experiments. (Credit: Image courtesy of McMaster University)

ScienceDaily (May 11, 2011) — New research from McMaster University may answer a controversial question: do the blind have a better sense of touch because the brain compensates for vision loss or because of heavy reliance on their fingertips?

The study, published in the most recent edition of the *Journal of Neuroscience*, suggests daily dependence on touch is the answer.

Twenty-eight profoundly blind participants -- with varying degrees of Braille expertise -- and 55 normally sighted adults were tested for touch sensitivity on six fingers and both sides of the lower lip.

Researchers reasoned that, if daily dependence on touch improves tactile sensitivity, then blind participants would outperform the sighted on all fingers, and blind Braille readers would show particular sensitivity on their reading fingers. But if vision loss alone improves tactile sensitivity, then blind participants would outperform the sighted on all body areas, even those that blind and sighted people use equally often, such as the lips.

"There have always been these two competing ideas about why blind people have a better sense of touch," explains Daniel Goldreich, corresponding author and a professor in the Department of Psychology,

Neuroscience & Behaviour. "We found that dependence on touch is a driving force here. Proficient Braille readers -- those who might spend hours a day reading with their fingertips -- performed remarkably better. But blind and sighted participants performed equally when the lips were tested for sensitivity."

Researchers used a specially-designed machine which held the pad of the participant's fingertip perfectly still for the experiments. While the finger lay over a hole in the table, the machine pushed rods with textured surfaces through the opening until they met the fingertip. Researchers asked subjects to identify the patterns by touch. A similar test was performed on the lower lip.

Not only did blind participants do better than their sighted peers, but Braille readers, when tested on their readings hands, outperformed nonreaders who were also blind. For Braille-reading participants, their reading fingers were more sensitive than their non-reading fingers.

"These results may help us design further experiments to determine how to improve the sense of touch, which could have applications later in life," says Mike Wong, study author and a graduate student in the McMaster Integrative Neuroscience Discovery & Study program. "Braille is extraordinarily difficult to master, particularly as an adult. In future we may find new ways to teach Braille to people who have recently become blind."

The research was funded by the Natural Sciences and Engineering Research Council of Canada (NSERC).

Story Source:

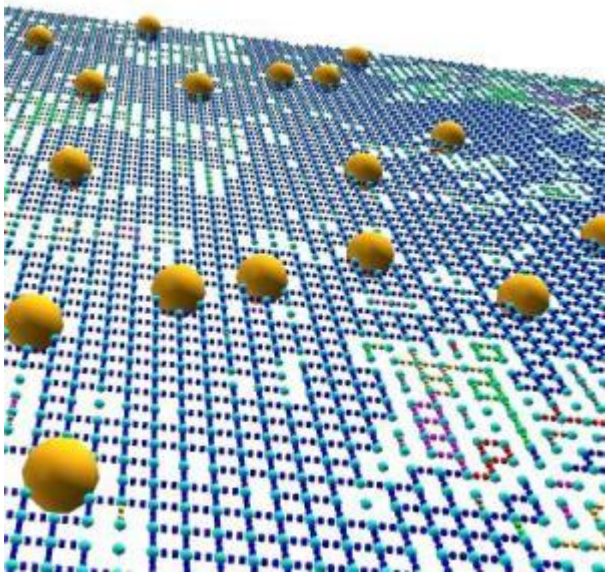
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **McMaster University**.

Journal Reference:

1. Michael Wong, Vishi Gnanakumaran and Daniel Goldreich. **Tactile Spatial Acuity Enhancement in Blindness: Evidence for Experience-Dependent Mechanisms**. *The Journal of Neuroscience*, 11 May 2011, 31(19):7028-7037 DOI: 10.1523/JNEUROSCI.6461-10.2011

http://www.sciencedaily.com/releases/2011/05/110511114209.htm

New Properties of Supercooled Confined Water Discovered



In this study, the team used Monte Carlo simulations to study a layer of water only one nanometre high – approximately equivalent to the diameter of three water molecules – confined between two hydrophobic plates. (Credit: Image courtesy of Universidad de Barcelona)

ScienceDaily (May 12, 2011) — A study led by the UB researcher Giancarlo Franzese and published in the journal *Physical Review Letters* suggests that hydrophobic nanoconfinement can alter the thermodynamics of water at supercool temperatures. These findings may have important applications in fields related to conservation at cryogenic temperatures (around -100 ºC) -- for example, in the preservation of stem cells, blood and food products.

The team behind the study, led by Giancarlo Franzese from the UB's Department of Fundamental Physics, included researchers from Boston University and TU Berlin.

Water exhibits atypical fluid behaviour. One of its unique characteristics is the increase in heat capacity as water cools, an anomaly that enables us to regulate our body temperature. When water is supercooled -- that is, when it is in liquid state at a temperature below its melting point -- the range of anomalies expands. This irregular behaviour has generated fierce scientific debate over the last twenty years and could hold the key to understanding why water is so different to other liquids and why it is so important for biological organisms.

From a technical perspective, it is difficult to observe supercooled water directly and many researchers opt to use nanoconfinement. In this study, the team used Monte Carlo simulations to study a layer of water only one nanometre high -- approximately equivalent to the diameter of three water molecules -- confined between two hydrophobic plates. Hydrophobic nanoparticles were then added to the water layer in random positions to generate nanochannels or variable size.

This process led to a strong decrease in thermodynamic fluctuations, reflected in compressibility, thermal expansion coefficient and specific heat. The observed decrease occurred at all pressures tested, and at pressures in the region of 180 MPa fluctuations dropped by almost 99% for a concentration in nanoparticles of 25% by volume. The reduction was found to be as high as 90% even at a particle concentration ten times lower.

According to Giancarlo Franzese, the results show that the thermodynamic behaviour of water confined in hydrophobic nanochannels is very different to that of unconfined water, even allowing for the possible presence of more than one liquid phase within the range of temperatures and pressures tested.

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Universidad de Barcelona**, via AlphaGalileo.

Journal Reference:

1. Elena Strekalova, Marco Mazza, H. Stanley, Giancarlo Franzese. **Large Decrease of Fluctuations for Supercooled Water in Hydrophobic Nanoconfinement**. *Physical Review Letters*, 2011; 106 (14) DOI: 10.1103/PhysRevLett.106.145701

http://www.sciencedaily.com/releases/2011/05/110512082945.htm

Study Reveals Origins of a Cancer Affecting the Blood and Bone Marrow

ScienceDaily (May 11, 2011) — A new study by the NYU Cancer Institute, an NCI-designated cancer center, sheds light on the origins of myeloid leukemia, a type of blood cancer that affects children and adults. The researchers discovered that novel mutations in an intracellular communication pathway called Notch led to the cancer, pointing to a potential new target for treating this disease. Notch has already been implicated in another type of blood cancer called T-cell acute lymphoblastic leukemia, but the new research found an unexpected role for it in myeloid leukemia.

The study is published in the May 12, 2011 issue of the journal *Nature*.

"This study shows the power of the Notch signaling pathway in myeloid leukemias," says Iannis Aifantis, PhD, associate professor in the Department of Pathology at NYU Langone Medical Center and a member of the NYU Cancer Institute, who led the new study. "This discovery," he says, "suggests a potential for future targeted therapies." Dr. Aifantis is also a Howard Hughes Medical Institute Early Career Scientist.

Last year, acute myeloid leukemia was diagnosed in more than 12,000 adults and the disease claimed nearly 9,000 lives in the United States, according to the National Cancer Institute. The blood cancer is the most common type of acute leukemia in adults. Normally, the bone marrow makes blood stem cells (immature) that mature over time. Some of these are a form called myeloid and others are lymphoid. The lymphoid stem cell develops into a white blood cell, while the more-versatile myeloid stem cell develops into red blood cells, white blood cells, and platelets, which prevent clotting. Cancer occurs when too many immature myeloid stem cells are produced in the blood and bone marrow.

The Notch signaling pathway, the complex web of intracellular interactions that occurs after a protein called Notch is activated on the cell's surface, is a well known actor in cancer, but the new study reveals that the varied members of this pathway function in unexpected ways to produce disease. Notch is named for a particular kind of mutation, first identified almost 100 years ago, that gives fruit flies notched wings.

The study evaluated mutations in the Notch pathway in mice models of the disease, and also in blood samples from patients with chronic myeloid leukemia. Researchers identified several mutations that inactivated or silenced the pathway, leading to the accelerated accumulation of abnormal blood cells. Most importantly, the study also revealed that the reactivation of the silenced genes in the pathway blocked the disease, providing additional support for the potentially crucial role that Notch might play in the development of cancer.

In a commentary accompanying the study in *Nature*, Demetrios Kalaitzidis and Scott A. Armstrong of Dana Farber Cancer Institute and Children's Hospital Boston, note that the study defines a new role for Notch signaling as a suppressor of leukemia development. They note that further research is needed to understand the intricacies of Notch signaling in normal and cancerous tissue, which will help determine "the best approaches to manipulating this pathway for optimal therapauetic response."

This research study was funded by the Howard Hughes Medical Institute.

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **NYU Langone Medical Center / New York University School of Medicine**, via EurekAlert!, a service of AAAS.

Journal Reference:

1. Apostolos Klinakis, Camille Lobry, Omar Abdel-Wahab, Philmo Oh, Hiroshi Haeno, Silvia Buonamici, Inge van De Walle, Severine Cathelin, Thomas Trimarchi, Elisa Araldi, Cynthia Liu, Sherif Ibrahim, Miroslav Beran, Jiri Zavadil, Argiris Efstratiadis, Tom Taghon, Franziska Michor, Ross L. Levine, Iannis Aifantis. **A novel tumour-suppressor function for the Notch pathway in myeloid leukaemia**. *Nature*, 2011; 473 (7346): 230 DOI: 10.1038/nature09999

http://www.sciencedaily.com/releases/2011/05/110512092716.htm

Foot and Mouth Disease May Spread Through Shedding Skin Cells

Cow stricken with foot-and-mouth disease in the UK. (Credit: Photo by Pam Hullinger)

ScienceDaily (May 10, 2011) — Skin cells shed from livestock infected with foot and mouth disease could very well spread the disease.

In a new paper appearing in the *Proceedings of the Royal Society B*, Lawrence Livermore National Laboratory scientist Michael Dillon proposed that virus-infected skin cells could be a source of infectious foot and mouth disease virus aerosols. His proposal is based on the facts that foot and mouth disease virus is found in skin and that airborne skin cells are known to transmit other diseases.

The proposal could lead to new methods for surveillance for foot and mouth disease (as in settled dust), the development of more effective control measures, and improved studies of the persistence of the disease in the environment. The research also may be applicable to how other infectious diseases are spread.

Foot and mouth is a highly contagious viral disease capable of causing widespread epidemics in livestock. The foot and mouth disease virus (FMDV) has multiple known routes of transmission. These include direct contact (animal-to-animal contact at mucous membranes, cuts or abrasions), indirect contact (such as contaminated bedding), ingestion (contaminated feed) and the respiratory or airborne pathway (inhalation of infectious aerosols).

"The airborne pathway may play a role in some outbreaks by causing disease 'sparks' (disease spread to regions remote from a primary infection site)," Dillon said. "If the disease isn't detected quickly, these 'sparks' can lead to major outbreaks."

Dillon cited the widespread dissemination of FMDV during the catastrophic 2001 United Kingdom outbreak, which is thought to be caused by the inadvertent transport of animals with unrecognized FMDV infection from a Prestwick area farm to areas previously free of FMDV.

Mammals actively shed skin cells into the environment. Skin cells comprise a significant fraction (1 percent to 10 percent) of measured indoor and outdoor aerosols and indoor dust. These cells; and the bacteria, yeast, fungi and viruses known to be present on the surface of (or in some cases inside) skin cells; can become airborne by being shed directly into the air or when dust is disturbed.

"Infectious material can become airborne on skin cells and cause infection when inhaled or deposited directly onto the skin of the new host," Dillon said. "This is believed to be a significant source of bacterial infection for surgical procedures and other infections that are a result of treatment in a hospital."

"While not a typical site for the initial FMDV infection, the skin is a major viral replication site in most animals," Dillon said. "The outermost layer of FMDV-infected skin needs to be analyzed to find out how stable the virus is in these skin cells."

Dillon's proposal suggests a number of practical possibilities for FMDV surveillance and control:

- The sampling and management of settled dust could prove to be a useful tool for disease surveillance and control.
- Slaughtered animals may emit airborne FMDV via infected skin cells simply by exposure to wind and/or mechanical abrasion (e.g. moving animal carcasses, spraying hides with water).
- Airborne emissions from cattle and sheep may need to be revisited as infected skin cells trapped in hair may later become airborne (currently these animals are believed to contribute little to aerosol emissions relative to swine).

"Given the potential for skin cells to protect infectious virus from the environment, the management of other viral diseases may also benefit from enhanced dust surveillance and management, and skin decontamination," Dillon said.

Story Source:

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

Journal Reference:

1. M. B. Dillon. **Skin as a potential source of infectious foot and mouth disease aerosols**. *Proceedings of the Royal Society B: Biological Sciences*, 2011; DOI: 10.1098/rspb.2010.2430

http://www.sciencedaily.com/releases/2011/05/110510134107.htm

Getting Along With Co-Workers May Prolong Life: But Support from the Boss Has No Effect on Mortality

ScienceDaily (May 10, 2011) — People who have a good peer support system at work may live longer than people who don't have such a support system, according research published by the American Psychological Association.

This effect of peer social support on the risk of mortality was most pronounced among those between the ages of 38 and 43. Yet similar support from workers' supervisors had no effect on mortality, the researchers found.

In addition, men who felt like they had control and decision authority at work also experienced this "protective effect," according to the study, published in the May issue of the APA journal *Health Psychology*. However, control and decision authority increased the risk of mortality among women in the sample.

"[P]eer social support, which could represent how well a participant is socially integrated in his or her employment context, is a potent predictor of the risk of all causes of mortality," the researchers wrote. "An additional (unexpected) finding … is that the effect of control on mortality risk was positive for the men but negative for the women."

The researchers rated peer social support as being high if participants reported that their co-workers were helpful in solving problems and that they were friendly. Control and decision authority were rated high if participants said they were able to use their initiative and had opportunities to decide how best to use their skills, and were free to make decisions on how to accomplish the tasks assigned to them and what to do in their jobs.

The researchers, at Tel Aviv University, looked at the medical records of 820 adults who were followed for 20 years, from 1988 to 2008. The workers were drawn from people who had been referred to an HMO's screening center in Israel for routine examinations. (People who were referred because of suspected physical or mental health problems were excluded from the sample). The workers came from some of Israel's largest firms in finance, insurance, public utilities, health care and manufacturing. They reported working on average 8.8 hours a day. One-third of them were women; 80 percent were married with children; and 45 percent had at least 12 years of formal education.

The researchers controlled for the physiological, behavioral and psychological risk factors of total cholesterol, triglycerides, glucose levels, blood pressure, body mass index, alcohol consumption, smoking, depressive symptoms, anxiety and past hospitalizations. They obtained the data on the control variables from each person's periodic health examinations, including tests of physiological risk factors and a questionnaire completed during the examinations by all participants.

In addition, participants were administered another questionnaire that measured job demands, control at work and peer and supervisor support. During the 20-year follow-up period, 53 participants died.

Asked why workplace control was positive for men but not women, the lead researcher, Arie Shirom, PhD, said that for employees in blue-collar type of jobs (and most respondents belonged to this category), high levels of control were found in jobs typically held by men, rather than jobs typically held by women. "Providing partial support to our finding, a past study found that for women in blue-collar jobs, having low levels of control does not increase their risk of becoming ill with stress-related disorders," Shirom said.

One limitation of the study was that the researchers did not have data on changes in workload, control or support during the 20-year period. "Still, we argue that other researchers have consistently found that the job characteristics of workload, control and support tend to be stable across time," Shirom said.

The American Psychological Association, in Washington, D.C., is the largest scientific and professional organization representing psychology in the United States and is the world's largest association of psychologists. APA's membership includes more than 154,000 researchers, educators, clinicians, consultants and students. Through its divisions in 54 subfields of psychology and affiliations with 60 state, territorial and Canadian provincial associations, APA works to advance psychology as a science, as a profession and as a means of promoting health, education and human welfare.

Story Source:

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

Journal Reference:

1. Arie Shirom, Sharon Toker, Yasmin Alkaly, Orit Jacobson, Ran Balicer. **Work-based predictors of mortality: A 20-year follow-up of healthy employees.**. *Health Psychology*, 2011; 30 (3): 268 DOI: 10.1037/a0023138

http://www.sciencedaily.com/releases/2011/05/110510121355.htm

New Class of Compounds Discovered With Great Potential for Research and Drug Development

ScienceDaily (May 15, 2011) — Scientists from The Scripps Research Institute have identified a class of compounds that could be a boon to basic research and drug discovery.

In a new study, published online in *Nature Chemical Biology* on May 15, 2011, the researchers show the new compounds powerfully and selectively block the activity of a large and diverse group of enzymes known as "serine hydrolases." Previously discovered serine hydrolase-blocking compounds have been turned into drugs to treat obesity, diabetes, and Alzheimer's disease, and are currently in testing as treatments for pain, anxiety, and depression.

"There are more than 200 serine hydrolases in human cells, but for most we've lacked chemical inhibitors of their activity," said team leader Benjamin F. Cravatt III, professor and chair of the Department of Chemical Physiology at Scripps Research and a member of its Skaggs Institute for Chemical Biology, "so we've had only a limited ability to study them in the lab or to block them to treat medical conditions. This new research allows us to greatly expand our list of these inhibitors."

A Scaffold on Which to Build

Hints from previous work by the Cravatt lab and other groups led the team to investigate a group of molecules known as ureas for their ability to inhibit serine hydrolase activity. In initial tests using recently advanced techniques for measuring enzyme-inhibition strength and specificity, the Scripps Research scientists found that molecules known as 1,2,3-triazole ureas could powerfully inhibit some serine hydrolases without affecting other enzymes.

In the next set of tests, the team synthesized a basic "scaffold" of 1,2,3-triazole urea, and found that it inhibited many more serine hydrolases -- still without affecting other enzyme classes -- than did an existing broad inhibitor known as a carbamate. The team then began modifying the scaffold compound to refine its inhibitory activity to specific serine hydrolase targets. This chemical tweaking would once have been a lengthy and burdensome task, but in this case it was done using simple "click chemistry" techniques developed at Scripps Research by Nobel laureate Professor K. Barry Sharpless and his colleague Associate Professor Valery Fokin.

"We can make these modifications in just two chemical steps, which is a great advantage," said Alexander Adibekian, a postdoctoral fellow in the Cravatt lab and first author of the new paper. "And despite this technical simplicity, we were able to generate compounds that were extremely potent and selective."

From the 20 compounds the scientists generated this way, they found three with powerful and highly specific inhibitory effects on individual serine hydrolases with many unknown characteristics.

Most of the study's enzyme-inhibition tests were conducted in mouse cell cultures, a more realistic biochemical environment than traditional "test-tube" biochemical preparations; but for one of the group's inhibitor compounds, AA74-1, the scientists extended their inhibition-measurement techniques to animal models, showing that the compound potently blocked the activity of its target serine hydrolase, acyl-peptide hydrolase, or APEH, without significantly affecting other enzymes.

Not much had been known about APEH, but with its inhibitor AA74-1, the team was able to illuminate the enzyme's normal role in the chemical modification of proteins, showing the levels of more than two dozen proteins dropped sharply when APEH was inhibited.

"This was unexpected and unusual," said Adibekian. "But it's what one wants to see with these compounds -- strong enzyme-inhibiting activity in different tissues, at a low dose. And it's the first time this kind of evaluation has been done in both cultured cells and animal tissues."

The Cravatt lab is now using the expanding number of inhibitors that team members have generated so far to study serine hydrolases with previously unknown or uncertain biological functions.

"We're also using the techniques described in this paper to try to systematically generate more of these inhibitor compounds," said Cravatt. "We see these compounds as basic tools that enable us to determine the roles of serine hydrolases in health and disease. As we understand these enzyme roles better, we expect that some of their inhibitors could become the bases for medicines."

This work was supported by the US National Institutes of Health, the Deutscher Akademischer Austausch Dienst, the US National Science Foundation, and the Skaggs Institute for Chemical Biology.

Story Source:

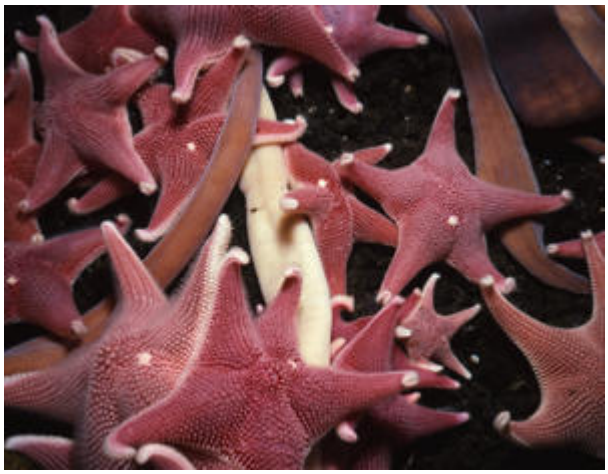
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Scripps Research Institute**, via EurekAlert!, a service of AAAS.

Journal Reference:

1. Alexander Adibekian, Brent R Martin, Chu Wang, Ku-Lung Hsu, Daniel A Bachovchin, Sherry Niessen, Heather Hoover & Benjamin F Cravatt. **Click-generated triazole ureas as ultrapotent in vivo-active serine hydrolase inhibitors**. *Nature Chemical Biology*, May 15, 2011 DOI: 10.1038/nchembio.579

http://www.sciencedaily.com/releases/2011/05/110515145812.htm

Marine Ecosystems of Antarctica Under Threat from Human Activity



Seastars and giant ribbon worms at McMurdo Sound, Antarctica, 32 metre depth. (Credit: Photo by R. B. Aronson)

ScienceDaily (May 16, 2011) — A team of scientists in the United Kingdom and the United States has warned that the native fauna and unique ecology of the Southern Ocean, the vast body of water that surrounds the Antarctic continent, is under threat from human activity.

Their study is published this week in the peer-reviewed journal *Annals of the New York Academy of Sciences.*

"Although Antarctica is still the most pristine environment on Earth, its marine ecosystems are being degraded through the introduction of alien species, pollution, overfishing, and a mix of other human activities," said team member Dr Sven Thatje of the University of Southampton's School of Ocean and Earth Science (SOES) based at the UK's National Oceanography Centre.

Biodiversity can be conceptualised in terms of its information content: the greater the diversity of species and interactions between them, the more 'information' the ecosystem has. "By damaging the ecological fabric of Antarctica, we are effectively dumbing it down -- decreasing its information content -- and endangering its uniqueness and resilience," said lead author Professor Richard Aronson, a paleoecologist at the Florida Institute of Technology, USA.

The team's conclusions are based on an extensive review of the impacts of a wide range of human activities on the ecosystems of Antarctica. The Antarctic Treaty system, which includes environmental and fisheries management, provides an effective framework for the management and protection of the continent, but some of the threats are not currently being fully addressed.

Some of these impacts, such as pollution, can be relatively localised. However, global climate change caused by human emissions of carbon dioxide and other greenhouse gases has the potential to affect the entire Antarctic region for decades to come.

The researchers point out that rising sea temperatures are already affecting marine creatures adapted to living within a particular temperature range.

A second major consequence of carbon dioxide emission from human activities -- ocean acidification -- is also likely to take its toll. "The Southern Ocean is the canary in the coal mine with respect to ocean

acidification. This vulnerability is caused by a combination of ocean mixing patterns and low temperature enhancing the solubility of carbon dioxide," noted co-author Dr. James McClintock of the University of Alabama at Birmingham, USA.

"Simultaneous action at local, regional and global scales is needed if we are to halt the damage being done to the marine ecosystems of the Southern Ocean," urged Dr Aronson.

The researchers have identified a range of historical and ongoing human activities that have damaged or restructured food webs in the Southern Ocean over recent decades. At the local to regional scale, these include -

- The hunting of top predators such as whales and seals.
- Overexploitation of some fish species, leading to stock collapses.
- Air and water pollution from shipping traffic, wrecks, and the transport of invasive alien species on hulls and in ballast tanks.
- Tourism, including potential disturbance to breeding bird and seal colonies, as well as being responsible for chemical and noise pollution, and littering.
- Chemical and sewage pollution from research stations and ships, the legacy of historical waste dumping, and pollution from scientific experiments, including lost or unrecovered equipment.

Antarctica has great, untapped natural resources. The Antarctic Treaty currently prohibits the extraction of oil and other mineral resources from Antarctica. The researchers note, however, that many major areas of the Southern Ocean fall outside the Antarctic Treaty region and could be claimed by nations as valuable 'real estate' for the future.

Although the Antarctic Treaty and other conventions have measures aimed at reducing the local- and regional-scale impacts of human activity on Antarctica and the Southern Ocean, they cannot address global-scale threats. Among these threats, the researchers highlight the following -

- Depletion of atmospheric ozone (O_3). The 'ozone hole' was discovered by BAS scientists in 1985 and is caused by the accumulation of atmospheric chlorofluorocarbons (CFCs) used as refrigerants and spray propellants.
- Introduced species. The researchers are concerned that the warming conditions in Antarctica could facilitate colonisation of species previously unreported from the region, with consequences for the structure of its marine food webs. Alien species accidentally introduced by humans are also a major concern.
- The vulnerability of cold-adapted species to observed rising sea temperatures caused by global warming. The researchers argue that the extinction of some species is likely, and that changes in the geographical distribution of others are to be expected. They warn that the further spread and establishment of predatory king crabs on the continental slope of the western Antarctic Peninsula could wreak havoc among its unique seafloor animal communities. The possible invasion by bottom-feeding fishes, rays and sharks with crushing jaws could be equally damaging. They also expect increasing dominance of salps over Antarctic krill, with consequences for animals such as whales, penguins and seals that depend either directly or indirectly on krill.
- Ocean acidification. The researchers note that organisms living in polar regions are uniquely vulnerable to the effects of ocean acidification because of low concentrations of dissolved calcium carbonate in the water column. They cite evidence that declining seawater pH will particularly affect organisms with calcified shells and skeletal elements, such as molluscs, seastars, sea urchins, coralline algae and cold-water corals, They also highlight evidence suggesting that ocean acidification could profoundly alter the structure and functioning of the planktonic food web, with unknown consequences for animals further up the food chain, including commercially exploited fish.

They therefore advocate continued and expanded baseline monitoring of ocean chemistry as well as further field and laboratory studies of the impacts of acidification on physiology, growth, and calcification.

"It is clear that multiple causal factors are damaging the health of marine systems in Antarctica; we need to understand the relative importance of these factors and how they interact." concluded Dr Thatje.

The researchers are Richard Aronson (Florida Institute of Technology), Sven Thatje (SOES), James McClintock (University of Alabama at Birmingham) and Kevin Hughes (British Antarctic Survey).

The research was supported by the US National Science Foundation, the Total Foundation (Abyss2100) and the Royal Society.

Story Source:

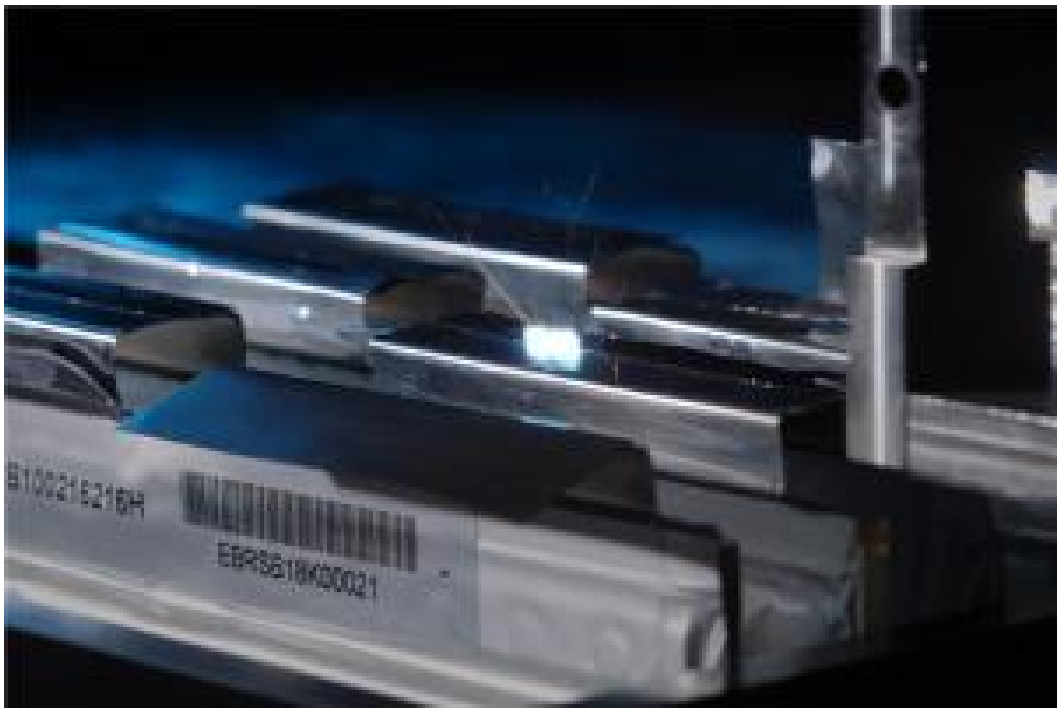
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **National Oceanography Centre, Southampton (UK)**.

Journal Reference:

1. Richard B. Aronson, Sven Thatje, James B. McClintock, Kevin A. Hughes. **Anthropogenic impacts on marine ecosystems in Antarctica**. *Annals of the New York Academy of Sciences*, 2011; 1223 (1): 82 DOI: 10.1111/j.1749-6632.2010.05926.x

http://www.sciencedaily.com/releases/2011/03/110331104003.htm

Lasers Take the Lead in Auto Manufacturing



Lasers can be used to process thin light-weight components made of fiber-composite materials, as well as to manufacture more efficient engines and more powerful batteries. (Credit: Image courtesy of Fraunhofer-Gesellschaft)

ScienceDaily (May 16, 2011) — Conserving energy is a top priority for auto manufacturers today. Laser technology can help. Lasers can be used to process thin light-weight components made of fiber-composite materials, as well as to manufacture more efficient engines and more powerful batteries. At the Laser 2011 trade fair from 23 -- 26 May, Fraunhofer scientists will be presenting new production technologies.

The era of gas guzzlers that clatter through streets and pollute the air is over. Cars rolling off the assembly line today are cleaner, quieter and -- in terms of their performance weight -- more efficient than ever before. Nevertheless, development continues. Ever-stricter environmental regulations and steadily rising fuel costs are increasing the demand for cars that further reduce their impact on the environment. But customer demands are often tough for manufacturers to meet: car bodies should be safe yet light-weight and engines durable yet efficient. Year after year, new models must be developed and built that can claim to be better, more efficient, and more intelligent than the last.

The race against time and competitors places high demands on manufacturers and their suppliers. Lasers can help them win the race. Resistant to wear and universally applicable, laser light is an ideal tool in the manufacture of vehicles. Lasers can be used to join, drill, structure, cut or shape any kind of material. Surfaces can be engineered for motors and drive trains that create less friction and use less fuel. Lasers are not only a decisive key towards faster, more efficient and economical production, but also towards energy-saving vehicles. At Laser 2011, Fraunhofer scientists will demonstrate how we can use lasers to save time, money and energy.

A weight-loss program in automotive manufacturing

Extra pounds cost energy. They have to be accelerated and slowed down every time you drive -- over the entire lifespan of the car. To reduce weight, manufacturers are increasingly turning to the use of fiber-reinforced plastics, which are 30 to 50 percent lighter than metal. The disadvantage, however, is that these new materials are difficult to process. Fiber-reinforced plastics are brittle, meaning cutting and drilling tools are quickly worn out and the conventional assembly techniques used for metal components are often not appropriate. "Lasers represent an ideal alternative here," explains Dr. Arnold Gillner of the Fraunhofer Institute for Laser Technology ILT in Aachen. "Lasers can cut fiber-reinforced plastics without wear and can join them too. With the appropriate lasers, we can cut and ablate components with minimal thermal side-effects. Lasers can also be used for welding light-weight components -- a viable alternative to conventional bonding technology. We can even join fiber-reinforced plastics to metals with laser welding. The laser roughens the metal surface, while the plastic, briefly-heated, penetrates the pores of the metal and hardens. The results are very stable."

Weight reduction can also be achieved with high-strength metallic materials. These, however, are difficult to process. "Joining combinations of various materials allows us to make optimal use of the individual materials' specific properties. But this proves to be difficult in many cases," explains Dr. Anja Techel, Deputy Director of the Fraunhofer Institute for Material and Beam Technology IWS in Dresden. Her team believes in lasers: "With our newly-developed integrated laser tools, we can now even weld together combinations of materials, free of fissures or cracks." At Laser 2011, Fraunhofer scientists will present, for the first time, a new welding head capable not only of focusing with extreme precision but of moving back and forth across the seam with high frequency to mix the molten materials. When they harden, they create a stable bond.

Laser replaces chemistry

Lasers also save time and money in tool design. The molds used in the production of plastic fixtures and steering wheels, for example, have to be structured to give the finished component a visually and tactilely appealing surface. Most car manufacturers order a design from their suppliers, whose surface typically has the appearance of leather. Until now, the negative pattern used to create the design has been etched out of the steel tools used in injection molding -- a tedious and time-consuming process. "With lasers, the steel surface can not only be patterned more quickly, but also with greater scope for variety," explains Kristian Arntz of the Fraunhofer Institute for Production Technology IPT. "We can transfer any possible design directly from the CAD model to the tool surface: What will later become a groove in the plastic is preserved as a ridge, while the surrounding material is vaporized. The process is efficient, fully automatic, and highly variable."

Saving energy with low friction motors

Laser technology is also in demand in engine optimization. Engineers strive to keep friction as low as possible in order to improve efficiency. "That is true not only for the electric engines currently being developed, but also for classic internal combustion engines and diesel motors, as well as transmissions and bearings," says Arnold Gillner of the ILT. Ceramic, high-performance coatings are especially desirable, because they are not only resistant to wear but also smooth, which generates less friction. Coated metal components have until now been prohibitively expensive, being produced in plasma chambers in which the ceramic was vaporized and applied to the surface of the components. Fraunhofer scientists have now developed a less expensive and faster method in which work pieces are coated with ceramic nano-particles, then treated with a laser. This finishing process has already been applied to gear wheels and bearings.

Lasers can even be used to make specific modifications to the properties of engine parts. "Friction between the cylinder wall and piston is responsible for a big part of a motor's energy consumption. That is why we try to minimize it. This is especially important for engines featuring modern, automatic start-stop functions that are stressed by frequent ignition," says Gillner. "To protect them, we have to ensure that the cylinder is always coated with a film of oil. Laser technology can help reduce friction with special structuring processes

that improve oil adhesion." Fraunhofer researchers aim to increase the engine's life-span and reduce energy consumption in this way.

Fitness program for electric cars

Lasers can even increase the efficiency and life-span of electric batteries. That is good news for manufacturers and owners of electric cars, since batteries continue to be extremely expensive. The engineers and scientists at Fraunhofer are currently working on various solutions to make batteries more durable and less expensive. One approach is to increase the surface area of the electrodes with appropriate coating in order to increase their efficiency. Another approach involves analyzing and optimizing production processes.

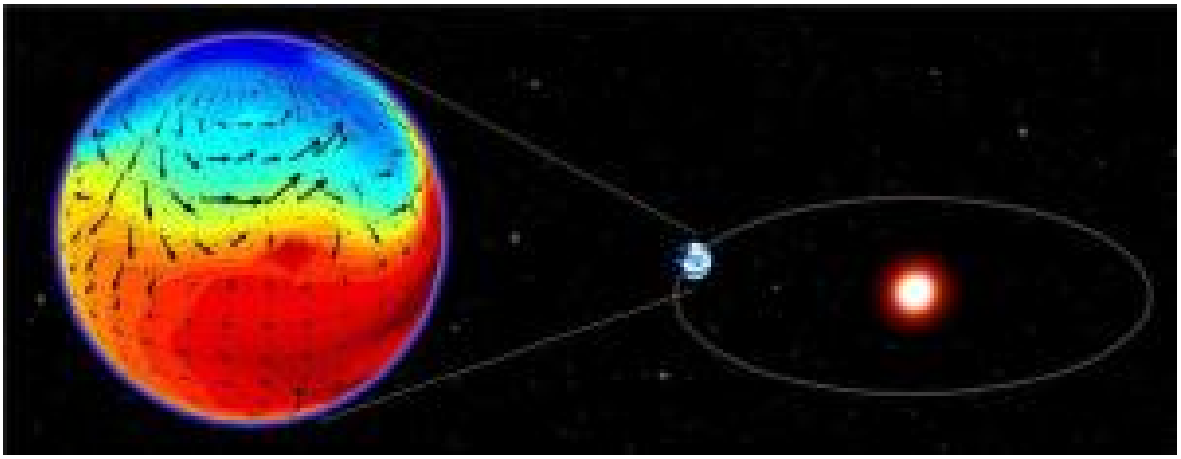
Manufacturers produce batteries using one anode and one cathode cell, which they then connect. In theory that sounds pretty simple, but in practice the fusing of copper anodes with aluminum cathodes creates brittle connections that break easily. That presents a problem for application in cars that sometimes drive on cobblestone or dirt roads. With the help of lasers, researchers at the ILT have succeeded in forming durable connections between electrodes without creating the culprit brittle alloys. Researchers at the IWS in Dresden have developed an alternative solution in which a laser warms the surfaces and rollers press them together. "Using roll plating with lasers and inductive pre-heating, we were able to create very stable connections with high electrical conductivity, with only a minimal loss of power," reports Anja Techel. "The finished batteries are very efficient. And since only small amounts of electrical energy are transformed into heat, these batteries do not require as much cooling."

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Fraunhofer-Gesellschaft**.

http://www.sciencedaily.com/releases/2011/05/110513112529.htm

First Habitable Exoplanet? Climate Simulation Reveals New Candidate That Could Support Earth-Like Life



Schematic of the global climate model used to study Gliese 581d. Red / blue shading indicate hot / cold surface temperatures, while the arrows show wind velocities at 2 km height in the atmosphere. (Credit: © LMD/CNRS)

ScienceDaily (May 16, 2011) — The planetary system around the red dwarf Gliese 581, one of the closest stars to the Sun in the galaxy, has been the subject of several studies aiming to detect the first potentially habitable exoplanet. Two candidates have already been discarded, but a third planet, Gliese 581d, can be considered the first confirmed exoplanet that could support Earth-like life. This is the conclusion of a team of scientists from the Institut Pierre Simon Laplace (CNRS, UPMC, ENS Paris, Ecole Polytechnique) in Paris, France, whose study is published in *The Astrophysical Journal Letters*.

Are there other planets inhabited like Earth, or at least habitable? The discovery of the first habitable planet has become a quest for many astrophysicists who look for rocky planets in the "habitable zone" around stars, the range of distances in which planets are neither too cold nor too hot for life to flourish.

In this quest, the red dwarf star Gliese 581 has already received a huge amount of attention. In 2007, scientists reported the detection of two planets orbiting not far from the inner and outer edge of its habitable zone. While the more distant planet, Gliese 581d, was initially judged to be too cold for life, the closer-in planet was thought to be potentially habitable by its discoverers. However, later analysis by atmospheric experts showed that if it had liquid oceans like Earth, they would rapidly evaporate in a 'runaway greenhouse' effect similar to that which gave Venus the hot, inhospitable climate it has today. A new possibility emerged late in 2010, when a team of observers led by Steven Vogt at the University of California, Santa Cruz, announced that they had discovered a new planet, which they dubbed Gliese 581g, or 'Zarmina's World'. This planet, they claimed, had a mass similar to that of Earth and was close to the centre of the habitable zone. For several months, the discovery of the first potential Earth twin outside the Solar System seemed to have been achieved. Unfortunately, later analysis by independent teams has raised serious doubts on this extremely difficult detection. Many now believe that Gliese 581g may not exist at all. Instead, it may simply be a result of noise in the ultra-fine measurements of stellar 'wobble' needed to detect exoplanets in this system.

Today, it is finally Gliese 581g's big brother -- the larger and more distant Gliese 581d -- which has been shown to be the confirmed potentially habitable exoplanet by Robin Wordsworth, François Forget and co-workers from Laboratoire de Météorologie Dynamique (CNRS, UPMC, ENS Paris, Ecole Polytechnique) at the Institute Pierre Simon Laplace in Paris. Although it is likely to be a rocky planet, it has a mass at least seven times that of Earth, and is estimated to be about twice its size. At first glance, Gliese 581d is a pretty poor candidate in the hunt for life: it receives less than a third of the stellar energy Earth does and may be

tidally locked, with a permanent day and night side. After its discovery, it was generally believed that any atmosphere thick enough to keep the planet warm would become cold enough on the night side to freeze out entirely, ruining any prospects for a habitable climate.

To test whether this intuition was correct, Wordsworth and colleagues developed a new kind of computer model capable of accurately simulating possible exoplanet climates. The model simulates a planet's atmosphere and surface in three dimensions, rather like those used to study climate change on Earth. However, it is based on more fundamental physical principles, allowing the simulation of a much wider range of conditions than would otherwise be possible, including any atmospheric cocktail of gases, clouds and aerosols.

To their surprise, they found that with a dense carbon dioxide atmosphere -- a likely scenario on such a large planet -- the climate of Gliese 581d is not only stable against collapse, but warm enough to have oceans, clouds and rainfall. One of the key factors in their results was Rayleigh scattering, the phenomenon that makes the sky blue on Earth. In the Solar System, Rayleigh scattering limits the amount of sunlight a thick atmosphere can absorb, because a large portion of the scattered blue light is immediately reflected back to space. However, as the starlight from Gliese 581 is red, it is almost unaffected. This means that it can penetrate much deeper into the atmosphere, where it heats the planet effectively due to the greenhouse effect of the CO2 atmosphere, combined with that of the carbon dioxide ice clouds predicted to form at high altitudes. Furthermore, the 3D circulation simulations showed that the daylight heating was efficiently redistributed across the planet by the atmosphere, preventing atmospheric collapse on the night side or at the poles.

Scientists are particularly excited by the fact that at 20 light years from Earth, Gliese 581d is one of our closest galactic neighbours. For now, this is of limited use for budding interstellar colonists -- the furthest-travelled human-made spacecraft, Voyager 1, would still take over 300,000 years to arrive there. However, it does mean that in the future telescopes will be able to detect the planet's atmosphere directly. While Gliese 581d may be habitable there are other possibilities; it could have kept some atmospheric hydrogen, like Uranus and Neptune, or the fierce wind from its star during its infancy could even have torn its atmosphere away entirely. To distinguish between these different scenarios, Wordsworth and co-workers came up with several simple tests that observers will be able to perform in future with a sufficiently powerful telescope.

If Gliese 581d does turn out to be habitable, it would still be a pretty strange place to visit -- the denser air and thick clouds would keep the surface in a perpetual murky red twilight, and its large mass means that surface gravity would be around double that on Earth. But the diversity of planetary climates in the galaxy is likely to be far wider than the few examples we are used to from the Solar System. In the long run, the most important implication of these results may be the idea that life-supporting planets do not in fact need to be particularly like Earth at all.

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **CNRS (Délégation Paris Michel-Ange)**.

1. Robin D. Wordsworth, François Forget, Franck Selsis, Ehouarn Millour, Benjamin Charnay, Jean-Baptiste Madeleine. **Gliese 581d is the first discovered terrestrial-mass exoplanet in the habitable zone**. *The Astrophysical Journal*, 2011; 733 (2): L48 DOI: 10.1088/2041-8205/733/2/L48

http://www.sciencedaily.com/releases/2011/05/110516080124.htm

Will Global Climate Change Enhance Boreal Forest Growth?

With an increasingly warmer climate, there is a trend for springs to arrive earlier and summers to be hotter. Since spring and summer are the prime growing seasons for plants -- when flowers bloom and trees increase in girth and height -- do these climate changes mean greater seasonal growth for plants? This is a critical question for forest management, especially in the boreal region -- an area particularly sensitive to the effects of climate change. (Credit: © MarisTerauds / Fotolia)

ScienceDaily (May 16, 2011) — With an increasingly warmer climate, there is a trend for springs to arrive earlier and summers to be hotter. Since spring and summer are the prime growing seasons for plants -- when flowers bloom and trees increase in girth and height -- do these climate changes mean greater seasonal growth for plants? This is a critical question for forest management, especially in the boreal region -- an area particularly sensitive to the effects of climate change.

Dr. Jian-Guo Huang, currently a post-doc at the University of Alberta, and colleagues from the University of Quebec at Montreal were interested in assessing whether a potentially extended growing season affects stem xylem formation and growth in black spruce (*Picea mariana*) in Western Quebec, Canada. They published their findings in the May issue of the *American Journal of Botany*.

Xylem cells conduct water and nutrients from roots to the leaves, but also provide mechanical support and form the wood of trees. Growth patterns of xylem are of interest to foresters because thicker-walled xylem cells produce denser wood -- and aspects of the climate, such as temperature and rainfall, may impact not only the number of cells produced during a growing season, but also cell wall thickness.

By taking microcore samples from black spruce trees at three different latitudes ranging from 47.5o to 50oN in Western Quebec throughout the growing season (May-September) in 2005 and 2006, Huang and colleagues were able to determine when xylem cell production began and ended, as well as the pattern of xylem cell growth. They then compared these data to soil and air temperature and precipitation data gathered from local climate stations.

"Every small wood xylem cell contains meteorological information during its growing process," Huang commented. "Exploring a series of micro-wood xylem cells helps us understand the macro-climate variability."

When the authors examined the pattern of xylem cell initiation, they found an interesting correlation with patterns in air temperatures in the two years. Across all three sites, xylem cell production in black spruce trees started earlier in 2006 than in 2005, corresponding with an earlier spring (and warmer May temperatures) in 2006 -- indicating a positive relationship between temperature and onset of xylem production.

Temperature affects not only when cells begin to grow, but also the growth patterns of those cells. Xylem cells produced early in the season -- earlywood -- are large in size with thin walls, while those produced later in the season -- latewood -- are smaller and have thicker walls.

Despite early warm temperatures in 2006, temperatures for the rest of the growing season were actually lower in June through August compared with 2005. And, correspondingly, Huang and co-authors found that in 2006 black spruce trees stopped producing both early and latewood earlier than in 2005. Consequently there were higher ratios of latewood cells to total xylem cells in 2006, and narrower, less-productive growth rings.

"Our study implies that despite the expected occurrence of earlier phenological development due to early spring climate warming, boreal trees like *Picea mariana* might not be producing wider rings if cold temperatures occur later in the growing season in June to August," Huang said. "These results may challenge the view that boreal trees could be benefiting from spring warming to enhance growth."

Thus, not only is the timing of the onset of spring important, but the amplitude of summer warming temperatures also plays a role in wood production.

Huang and his colleagues intend to further explore how intra-annual xylem formation of other boreal species, particularly broadleaf species, is responding to climate warming and varies across species and sites.

"Because broadleaf species are more limited by precipitation, early spring warming (i.e., early onset of cell production) followed by cold June-August temperatures (i.e., less drought stress) might favor xylem cell production, resulting in wider rings and better growth, when compared with conifers like *Picea mariana*," commented Huang. "These different growth responses to climate warming across species might lead to potential changes in forest growth, structure and composition, as well as the whole forest ecosystem productivity, and carbon equilibrium."

Story Source:

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

Journal Reference:

1. J.-G. Huang, Y. Bergeron, L. Zhai, B. Denneler. **Variation in intra-annual radial growth (xylem formation) of Picea mariana (Pinaceae) along a latitudinal gradient in western Quebec, Canada**. *American Journal of Botany*, 2011; 98 (5): 792 DOI: 10.3732/ajb.1000074

http://www.sciencedaily.com/releases/2011/05/110516102251.htm

Applying Neuroscience to Robot Vision

ScienceDaily (May 16, 2011) — Scientists have attempted to replicate human attributes and abilities such as detailed vision, spatial perception and object grasping in robots.

After three years of intense work, the members of EYESHOTS* have made progress in controlling the interaction between vision and movement, and as a result have designed an advanced three-dimensional visual system synchronized with robotic arms which could allow robots to observe and be aware of their surroundings and also remember the contents of those images in order to act accordingly.

For a humanoid robot to successfully interact with its environment and develop tasks without supervision, it is first necessary to refine these basic mechanisms that are still not completely resolved, says Spanish researcher Ángel Pasqual del Pobil, director of the Robotic Intelligence Laboratory of the Universitat Jaume I. His team has validated the members' findings with a system built at the University of Castellón (Spain) consisting of a robot head with moving eyes integrated into a torso with articulated arms.

To make the computer models the team started from the knowledge of animal and human biology, for which experts specialised in neuroscience, psychology, robotics and engineering worked together. The study began by recording monkeys' neurons engaged in visual-motor coordination, as humans share our way of perceiving the world with primates.

The first feature of our visual system that the members replicated artificially was our saccadic eye movement which is related to the dynamic change of attention. According to Dr. Pobil: "We constantly change the point of view through very fast eye movements, so fast that we are hardly aware of it. When the eyes are moving, the image is blurred and we can't see clearly. Therefore, the brain must integrate the fragments as if it were a puzzle to give the impression of a continuous and perfect image of our surroundings."From the neural data, the experts developed computer models of the section of the brain that integrates images with movements of both eyes and arms. This integration is very different from that which is normally carried out by engineers and experts in robotics. The EYESHOTS consortium set out to prove that when we make a grasping movement towards an object, our brain does not previously have to calculate the coordinates.

As the Spanish researcher explains: "The truth is that the sequence is much more straightforward: our eyes look at a point and *tell* our arm where to go. Babies learn this progressively by connecting neurons." Therefore, these learning mechanisms have also been simulated in EYESHOTS through a neural network that allows robots to learn how to look, how to construct a representation of the environment, how to preserve the appropriate images, and use their memory to reach for objects even if these are out of their sight at that moment."Our findings can be applied to any future humanoid robot capable of moving its eyes and focusing on one point. These are priority issues for the other mechanisms to work correctly," points out the researcher.

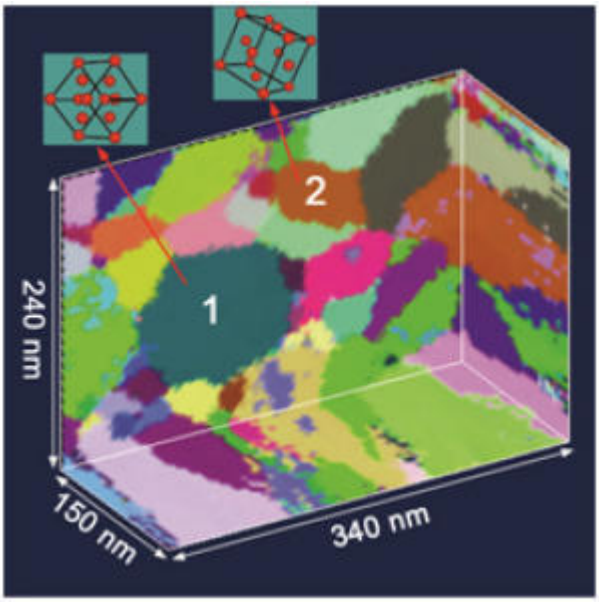
EYESHOTS was funded by the European Union through the Seventh Framework Programme and coordinated by the University of Genoa (Italy).

* EYESHOTS (Heterogeneous 3-D Visual Perception Across Fragments)

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Asociación RUVID**, via AlphaGalileo.

http://www.sciencedaily.com/releases/2011/05/110516091230.htm

Looking Inside Nanomaterials in 3-D



Three-Dimensional Orientation Mapping in the Transmission Electron. This image shows the arrangement of crystals in a 150nm thick nanometal aluminium film. The crystals have identical lattice structure (arrangement of atoms) but they are orientated in different ways in the 3-D sample as illustrated by the labels 1 and 2. The colours represent the orientations of the crystals and each crystal is defined by volumes of the same colour. The individual crystals of various sizes (from a few nm to about 100 nm) and shapes (from elongated to spherical) are clearly seen and mapped with a resolution of 1 nanometer. (Credit: Image courtesy of Risø National Laboratory for Sustainable Energy)

ScienceDaily (May 16, 2011) — Scientists from Denmark, China and USA have developed a new method for revealing 3-D images of the structure inside a material.

Most solid materials are composed of millions of small crystals, packed together to form a fully dense solid. The orientations, shapes, sizes and relative arrangement of these crystals are important in determining many material properties.

Traditionally, it has only been possible to see the crystal structure of a material by looking at a cut surface, giving just 2D information. In recent years, x-ray methods have been developed that can be used to look inside a material and obtain a 3-D map of the crystal structure. However, these methods have a resolution limit of around 100nm (one nanometer is 100,000 times smaller than the width of a human hair).

In contrast, the newly developed technique now published in the journal *Science*, allows 3-D mapping of the crystal structure inside a material down to nanometer resolution, and can be carried out using a transmission electron microscope, an instrument found in many research laboratories.

Samples must be thinner than a few hundred nanometers. However, this limitation is not a problem for investigations of crystal structures inside nanomaterials, where the average crystal size is less than 100 nanometers, and such materials are investigated all over the world in a search for materials with new and better properties than the materials we use today.

For example, nanomaterials have an extremely high strength and an excellent wear resistance and applications therefore span from microelectronics to gears for large windmills. The ability to collect a 3-D picture of the crystal structure in these materials is an important step in being able to understand the origins of their special properties.

An important advantage of such 3-D methods is that they allow the changes taking place inside a material to be observed directly. For example, the mapping may be repeated before and after a heat treatment revealing how the structure changes during heating.

This new technique has a resolution 100 times better than existing non-destructive 3-D techniques and opens up new opportunities for more precise analysis of the structural parameters in nanomaterials.

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Risø National Laboratory for Sustainable Energy**.

Journal Reference:

1. H. H. Liu, S. Schmidt, H. F. Poulsen, A. Godfrey, Z. Q. Liu, J. A. Sharon, X. Huang. **Three-Dimensional Orientation Mapping in the Transmission Electron Microscope**. *Science*, 2011; 332 (6031): 833 DOI: 10.1126/science.1202202

http://www.sciencedaily.com/releases/2011/05/110516080306.htm

Species Are to Ecosystems as Cells Are to the Human Body, According to a Mathematical Model

An ecosystem is like a great organism in that the species in it behave in a manner similar to the manner in which cells behave within the human body: the group forms a permanent entity, although the entities that form it are constantly being substituted. (Credit: I.C./SINC)

ScienceDaily (May 16, 2011) — An ecosystem is like a great organism in that the species in it behave in a manner similar to the manner in which cells behave within the human body: the group forms a permanent entity, although the entities that form it are constantly being substituted. This is is the conclusion that can be drawn from a theoretical study carried out by researchers at the Universidad Carlos III de Madrid (UC3M -- Carlos III University of Madrid).

These scientists have developed a mathematical model that recreates the behavior of an ecosystem in order to observe its dynamics and its reactions in different situations. And what they have discovered is that the ecosystem reaches a state in which it remains more or less unchanged, in spite of the fact that the species that make it up are continuously substituted by others, even to the point that a complete change takes place, similar to the change that occurs inside a human organism. "In short: the species change, but the structure does not," comments Professor José A. Cuesta, one of the authors of the study, along with José A. Capitán. Both are members of the Mathematics Department of UC3M. Jordi Bascompte, of the Consejo Superior de Investigaciones Científicas (CSIC -- the Spanish National Research Council), is the third author of the study, which was recently published in the *Journal of Theoretical Biology*.

The authors comment that from this perspective, it could be stated that multiccellular beings are also ecosystems. That is, we are formed by different types of cells that cooperate and compete for resources; we are colonized by diverse types of bacteria (in the intestines, in the skin, etc.) whose activity is linked to other processes in our organism: we are invaded by viruses, which can be harmful or can take part in processes that regulate our DNA. "These beings are constantly being changed, in such a way that after a long enough time passes, all of the entities that form us have been substituted one or more times. Nevertheless, throughout the process, we continue to be ourselves. This is the same thing that happens with ecosystems," explains Prof. Cuesta.

The most important implication of this finding is that it forces us to see ecosystems in a different light, as self-contained entities rather than as collections of species. "We are obsessed with the preservation of species, but it is much more important to preserve ecosystems," these scientists point out. Seen this way, for example, at times it could be beneficial to substitute an endangered species with another one -- with similar interactions with the other species in the ecosystems -- so that the ecosystem will not be threatened, because then we would lose one species, but we would save the ecosystem.

In the field of evolution when the term 'ecosystem' is used, a distinction is always made between species and environment. The former evolves in order to adapt to the latter and it changes along with its environment. In light of of this dichotomy, there is a tendency to think of species and environments as separate entities. However, ecosystems demonstrate that the species themselves form the most important part of the environment or ecosystem. "The species interact: they eat each other, they fight for territory... and this causes the presence or absence of certain species to be the most influential factor in the survival of another species," comments the researcher. "This property that species have, which allows them to generate their own environment and form an ecosystem, is the aspect that we were most interested in when we approached this study," comments José A. Cuesta, who is also part of the Grupo Interdisciplinar de Sistemas Complejos (Complex Systems Interdisciplinary Group) at UC3M.

The mathematical model that these researchers have created allows them to observe ecosystems over long periods of time, as well as during their formation, thus allowing them to form other hypotheses as well. They have seen, for example, that an ecosystem is formed as it is invaded by new species, but that there is a point at which the ecosystem becomes robust and no longer permits further additions to its structure, although it does allow the exchange of elements. Another piece of evidence that they have proved is the "large predator" effect, which has been observed in real ecosystems. This effect occurs when the extinction of a large predator that consumes a variety of species leads to the subsequent extinction of the species the predator had previously preyed upon. The reason is that the predator had acted as a regulator of the prey's population. Consequently, when the predator is no longer present, the prey's population grows to the point that depletes its resources, which leads to its extinction, as well.

There are several advantages to creating a mathematical model when studying Nature. First, the temporal scale of an ecosystem's evolution can be enormous and it would require data to be gathered over centuries and even millennia, which would be unviable. Second, the empirical analysis of ecosystems is extremely difficult, because it requires observing all of the species involved over long periods of time, having sufficient observations of predators and prey so that reliable food chain relationships can be inferred and the parameters of competition among the species can be estimated... Also, throughout the period in which the ecosystem is being observed, it may be subject to seasonal or climatic changes that may influence all of these relationships. "Mathematical models turn out to be very helpful for focusing on the type of data to be gathered in order to verify hypotheses. In fact, mathematical ecology has a long tradition in this discipline and ecologists themselves are doing very interesting things by applying mathematical techniques that were developed for use with other phenomena ," assures Prof. José Cuesta.

Story Source:

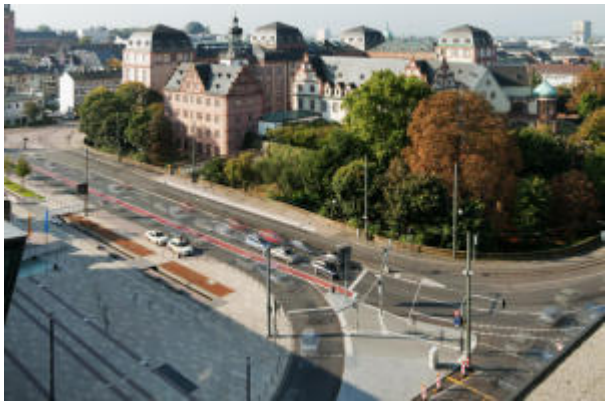
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Universidad Carlos III de Madrid - Oficina de Información Científica**.

Journal Reference:

1. José A. Capitán, José A. Cuesta, Jordi Bascompte. **Species assembly in model ecosystems, II: Results of the assembly process**. *Journal of Theoretical Biology*, 2011; 269 (1): 344 DOI: 10.1016/j.jtbi.2010.10.031

http://www.sciencedaily.com/releases/2011/05/110516080132.htm

Beyond Smart Phones: Sensor Network to Make 'Smart Cities' Envisioned



Car-to-car communications could help to prevent traffic jams. (Credit: Copyright Thomas Ott)

ScienceDaily (May 16, 2011) — Thanks to numerous sensors, Smartphones make it easy for their owners to organize certain parts of their lives. However, that is just the beginning. Darmstadt researchers envision entire "smart" cities, where all devices present within municipal areas are intelligently linked to one another.

Computer scientists, electrical and computer engineers, and mathematicians at the TU Darmstadt and the University of Kassel have joined forces and are working on implementing that vision under their "Cocoon" project. The backbone of a "smart" city is a communications network consisting of sensors that receive streams of data, or signals, analyze them, and transmit them onward. Such sensors thus act as both receivers and transmitters, i.e., represent transceivers. The networked communications involved operates wirelessly via radio links, and yields added values to all participants by analyzing the input data involved. For example, the "Smart Home" control system already on the market allows networking all sorts of devices and automatically regulating them to suit demands, thereby allegedly yielding energy savings of as much as fifteen percent.

"Smart Home" might soon be followed by "Smart Hospital," "Smart Industry," or "Smart Farm," and even "smart" systems tailored to suit mobile networks are feasible. Traffic jams may be avoided by, for example, car-to-car or car-to-environment (car-to-X) communications. Health-service systems might also benefit from mobile, sensor communications whenever patients need to be kept supplied with information tailored to suit their healthcare needs while underway. Furthermore, sensors on their bodies could assess the status of their health and automatically transmit calls for emergency medical assistance, whenever necessary.

"Smart" and mobile, thanks to beam forming

The researchers regard the ceaseless travels of sensors on mobile systems and their frequent entries into/exits from instrumented areas as the major hurdle to be overcome in implementing their vision of "smart" cities. Sensor-aided devices will have to deal with that by responding to subtle changes in their environments and flexibly, efficiently, regulating the qualities of received and transmitted signals. Beam forming, a field in which the TU Darmstadt's Institute for Communications Technology is active, should help out there. On that subject, Prof. Rolf Jakoby of the TU Darmstadt's Electrical Engineering and Information Technology Dept. remarked that, "Current types of antennae radiate omnidirectionally, like light bulbs. We intend to create conditions, under which antennae will, in the future, behave like spotlights that, once they have located a sought device, will track it, while suppressing interference by stray electromagnetic radiation from other devices that might also be present in the area."

Such antennae, along with transceivers equipped with them, are thus reconfigurable, i.e., adjustable to suit ambient conditions by means of onboard electronic circuitry or remote controls. Working in collaboration

with an industrial partner, Jakoby has already equipped terrestrial digital-television (TDTV) transmitters with reconfigurable amplifiers that allow amplifying transmitted-signal levels by as much as ten percent. He added that, "If all of Germany's TDTV-transmitters were equipped with such amplifiers, we could shut down one nuclear power plant."

Frequency bands are a scarce resource

Reconfigurable devices also make much more efficient use of a scarce resource, frequency bands. Users have thus far been allocated rigorously defined frequency bands, where only fifteen to twenty percent of the capacities of even the more popular ones have been allocated. Beam forming might allow making more efficient use of them. Jakoby noted that, "This is an area that we are still taking a close look at, but we are well along the way toward understanding the system better." However, only a few uses of beam forming have emerged to date, since currently available systems are too expensive for mass applications.

Small, model networks are targeted

Yet another fundamental problem remains to be solved before "smart" cities may become realities. Sensor communications requires the cooperation of all devices involved, across all communications protocols, such as "Bluetooth," and across all networks, such as the European Global System for Mobile Communications (GSM) mobile-telephone network or wireless local-area networks (WLAN), which cannot be achieved with current devices, communications protocols, and networks. Jakoby explained that, "Converting all devices to a common communications protocol is infeasible, which is why we are seeking a new protocol that would be superimposed upon everything and allow them to communicate via several protocols." Transmission channels would also have to be capable of handling a massive flood of data, since, as Prof. Abdelhak Zoubir of the TU Darmstadt's Electrical Engineering and Information Technology Dept., the "Cocoon" project's coordinator, put it, "A "smart" Darmstadt alone would surely involve a million sensors communicating with one another via satellites, mobile telephones, computers, and all of the other types of devices that we already have available. Furthermore, since a single, mobile sensor is readily capable of generating several hundred Mega-bytes of data annually, new models for handling the communications of millions of such sensors that will more densely compress data in order to provide for error-free communications will be needed. Several hurdles will thus have to be overcome before "smart" cities become reality. Nevertheless, the scientists working on the "Cocoon" project are convinced that they will be able to simulate a "smart" city incorporating various types of devices employing early versions of small, model networks.

Over the next three years, scientists at the TU Darmstadt will be receiving a total of 4.5 million Euros from the State of Hesse's Offensive for Developing Scientific-Economic Excellence for their researches in conjunction with their "Cocoon -- Cooperative Sensor Communications" project.

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Technische Universität Darmstadt**.

http://www.sciencedaily.com/releases/2011/05/110516080130.htm