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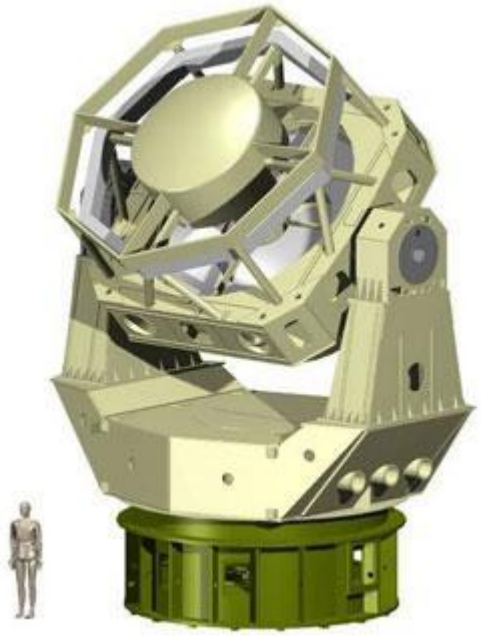
CONTENTS

Telescope will track space junk

US military unveils instrument to catalogue debris and protect satellites from collisions.
Gwyneth Dickey Zakaib



The telescope will scan for debris that could threaten satellites in geosynchronous orbit.Lt Col Travis Blake, Ph.D., USAF - Program Manager for DARPA SST program

A ground-based telescope that can scan the skies faster than any other of its size could help to protect satellites from collisions with space debris and each other. The Space Surveillance Telescope (SST), developed by the US Defense Advanced Research Projects Agency (DARPA), is to be used to protect US and international assets and commercial and international satellites in orbit around Earth.

"We've got a lot of high-value missions up there, and if you're trying to do those missions with a blindfold on, you just don't know what's going to run into you at any time," says Chuck Laing, deputy division chief of the Architecture and Integration branch of Air Force Space Command at Peterson Air Force Base in Colorado. "It's important to know where everything is, how fast it's moving, and in what direction."

Researchers are currently tracking an estimated 22,000 artificial objects that are orbiting Earth, from small bits of debris to large satellites. That number is expected to triple in the next 20 years, says Laing. Even a centimetre-sized piece of debris can cause considerable damage to crucial weather, communication or missile-warning systems.

The US Air Force keeps a catalogue of all known orbiting objects through its Space Surveillance Network, an integrated system of ground- and space-based telescopes and radar. The network tracks debris to anticipate possible impacts, but better surveillance is needed to cope with the increasing number of objects, says Laing. The SST would focus mostly on the region in which objects in geosynchronous orbit reside, about 35,000 kilometres from Earth.

The telescope, which took nine years and US$110 million to build, has a wide field of view, is very sensitive and can scan the sky several times in one night. It can collect data faster for dimmer objects than existing telescopes in the Space Surveillance Network. With the increased information that it provides, officials will be able to better predict the path of debris and warn satellite operators of potential collisions.

"You can make a better decision if you have more data to feed into the model," says Laing.

Eye on the sky

The telescope's superior data-collection capacity comes from its 3.5-meter aperture, which is more than three times the size of ground-based telescopes already in use. It also has a three-mirror system to bring images into sharp focus over a wide field. But the engineering advances brought problems: whereas traditional two-

mirrored telescopes focus light onto a flat surface, the three-mirrored type focuses onto a curved one, which makes it difficult to manufacture matching detectors.

"We had to do pretty hard work on the optics," says Grant Stokes, head of the aerospace division at the Massachusetts Institute of Technology's Lincoln Laboratory in Lexington. His lab developed curved charge-coupled devices that capture photons and turn them into electrons for digital processing in the telescope.

The SST took its first images in February 2011 and is currently being tested and aligned. It still has to pass an evaluation before joining the Space Surveillance Network.

If it passes the tests, the SST could begin collecting data in about six months. And if it's a big enough improvement on current technology, the Air Force might place similar telescopes at key sites around the globe for 360-degree surveillance. At the moment, the SST sees only the night sky visible from its base at the White Sands Missile Range near Socorro, New Mexico.

Researchers won't be able to use the telescope for their experiments, says Joseph Gambrell, chief of space situational awareness at the Air Force Space Command. "If we're going to try and get the most out of it, we really do need to maintain it as a Space Surveillance Network resource," he says.

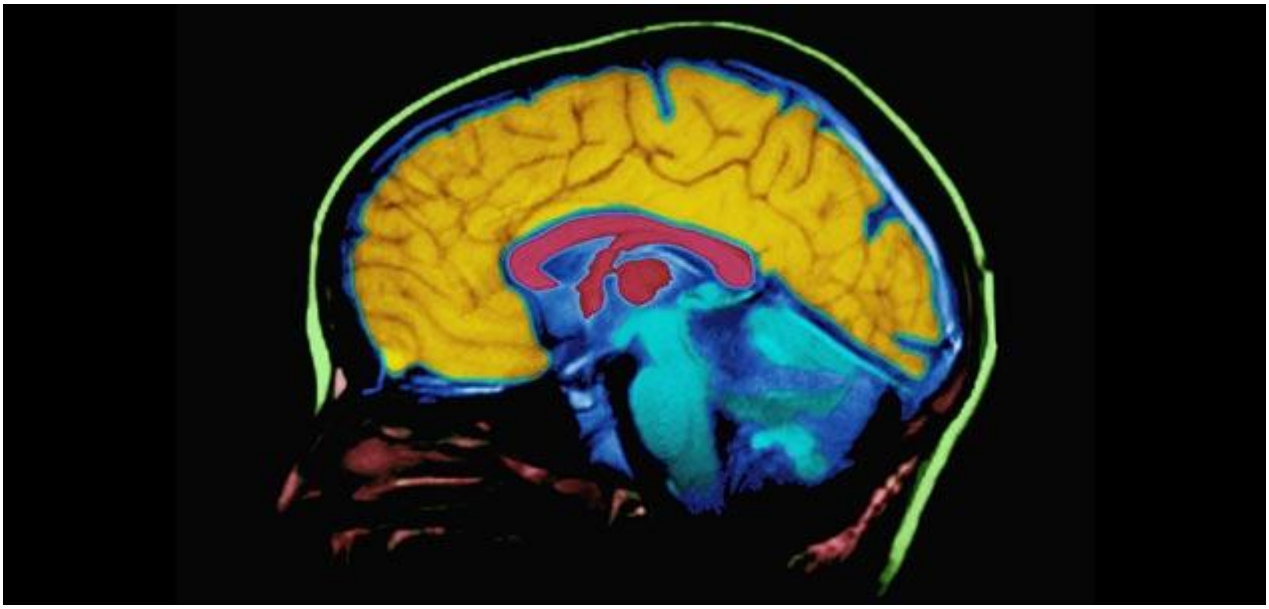
But a subset of the data might be made available on a website operated by US Strategic Command, and researchers might be able to get further data on request, says Gambrell.

http://www.nature.com/news/2011/110422/full/news.2011.254.html

Top Ten Myths About the Brain

When it comes to this complex, mysterious, fascinating organ, what do—and don't—we know?

- By Laura Helmuth
- Smithsonian.com, May 20, 2011



Repeated in pop culture for a century, the notion that humans only use 10 percent of our brains is false. Scans have shown that much of the brain is engaged even during simple tasks.

1. We use only 10 percent of our brains.

This one sounds so compelling—a precise number, repeated in pop culture for a century, implying that we have huge reserves of untapped mental powers. But the supposedly unused 90 percent of the brain is not some vestigial appendix. Brains are expensive—it takes a lot of energy to build brains during fetal and childhood development and maintain them in adults. Evolutionarily, it would make no sense to carry around surplus brain tissue. Experiments using PET or fMRI scans show that much of the brain is engaged even during simple tasks, and injury to even a small bit of brain can have profound consequences for language, sensory perception, movement or emotion.

True, we have some brain reserves. Autopsy studies show that many people have physical signs of Alzheimer's disease (such as amyloid plaques among neurons) in their brains even though they were not impaired. Apparently we can lose some brain tissue and still function pretty well. And people score higher on IQ tests if they're highly motivated, suggesting that we don't always exercise our minds at 100 percent capacity.

2. "Flashbulb memories" are precise, detailed and persistent.

We all have memories that feel as vivid and accurate as a snapshot, usually of some shocking, dramatic event—the assassination of President Kennedy, the explosion of the space shuttle Challenger, the attacks of September 11, 2001. People remember exactly where they were, what they were doing, who they were with, what they saw or heard. But several clever experiments have tested people's memory immediately after a tragedy and again several months or years later. The test subjects tend to be confident that their memories are accurate and say the flashbulb memories are more vivid than other memories. Vivid they may be, but the memories decay over time just as other memories do. People forget important details and add incorrect ones, with no awareness that they're recreating a muddled scene in their minds rather than calling up a perfect, photographic reproduction.

3. It's all downhill after 40 (or 50 or 60 or 70).

It's true, some cognitive skills do decline as you get older. Children are better at learning new languages than adults—and never play a game of concentration against a 10-year-old unless you're prepared to be humiliated. Young adults are faster than older adults to judge whether two objects are the same or different; they can more easily memorize a list of random words, and they are faster to count backward by sevens.

But plenty of mental skills improve with age. Vocabulary, for instance—older people know more words and understand subtle linguistic distinctions. Given a biographical sketch of a stranger, they're better judges of character. They score higher on tests of social wisdom, such as how to settle a conflict. And people get better and better over time at regulating their own emotions and finding meaning in their lives.

4. We have five senses.

Sure, sight, smell, hearing, taste and touch are the big ones. But we have many other ways of sensing the world and our place in it. Proprioception is a sense of how our bodies are positioned. Nociception is a sense of pain. We also have a sense of balance—the inner ear is to this sense as the eye is to vision—as well as a sense of body temperature, acceleration and the passage of time.

Compared with other species, though, humans are missing out. Bats and dolphins use sonar to find prey; some birds and insects see ultraviolet light; snakes detect the heat of warmblooded prey; rats, cats, seals and other whiskered creatures use their "vibrissae" to judge spatial relations or detect movements; sharks sense electrical fields in the water; birds, turtles and even bacteria orient to the earth's magnetic field lines.

By the way, have you seen the taste map of the tongue, the diagram showing that different regions are sensitive to salty, sweet, sour or bitter flavors? Also a myth.

5. Brains are like computers.

We speak of the brain's processing speed, its storage capacity, its parallel circuits, inputs and outputs. The metaphor fails at pretty much every level: the brain doesn't have a set memory capacity that is waiting to be filled up; it doesn't perform computations in the way a computer does; and even basic visual perception isn't a passive receiving of inputs because we actively interpret, anticipate and pay attention to different elements of the visual world.

There's a long history of likening the brain to whatever technology is the most advanced, impressive and vaguely mysterious. Descartes compared the brain to a hydraulic machine. Freud likened emotions to pressure building up in a steam engine. The brain later resembled a telephone switchboard and then an electrical circuit before evolving into a computer; lately it's turning into a Web browser or the Internet. These metaphors linger in clichés: emotions put the brain "under pressure" and some behaviors are thought to be "hard-wired."

Speaking of which...

6. The brain is hard-wired.

This is one of the most enduring legacies of the old "brains are electrical circuits" metaphor. There's some truth to it, as with many metaphors: the brain is organized in a standard way, with certain bits specialized to take on certain tasks, and those bits are connected along predictable neural pathways (sort of like wires) and communicate in part by releasing ions (pulses of electricity).

But one of the biggest discoveries in neuroscience in the past few decades is that the brain is remarkably plastic. In blind people, parts of the brain that normally process sight are instead devoted to hearing. Someone practicing a new skill, like learning to play the violin, "rewires" parts of the brain that are responsible for fine motor control. People with brain injuries can recruit other parts of the brain to compensate for the lost tissue.

7. A conk on the head can cause amnesia.

Next to babies switched at birth, this is a favorite trope of soap operas: Someone is in a tragic accident and wakes up in the hospital unable to recognize loved ones or remember his or her own name or history. (The only cure for this form of amnesia, of course, is another conk on the head.)

In the real world, there are two main forms of amnesia: anterograde (the inability to form new memories) and retrograde (the inability to recall past events). Science's most famous amnesia patient, H.M., was unable to remember anything that happened after a 1953 surgery that removed most of his hippocampus. He remembered earlier events, however, and was able to learn new skills and vocabulary, showing that encoding "episodic" memories of new experiences relies on different brain regions than other types of learning and memory do. Retrograde amnesia can be caused by Alzheimer's disease, traumatic brain injury (ask an NFL player), thiamine deficiency or other insults. But a brain injury doesn't selectively impair autobiographical memory—much less bring it back.

8. We know what will make us happy.

In some cases we haven't a clue. We routinely overestimate how happy something will make us, whether it's a birthday, free pizza, a new car, a victory for our favorite sports team or political candidate, winning the lottery or raising children. Money does make people happier, but only to a point—poor people are less happy than the middle class, but the middle class are just as happy as the rich. We overestimate the pleasures of solitude and leisure and underestimate how much happiness we get from social relationships.

On the flip side, the things we dread don't make us as unhappy as expected. Monday mornings aren't as unpleasant as people predict. Seemingly unendurable tragedies—paralysis, the death of a loved one—cause grief and despair, but the unhappiness doesn't last as long as people think it will. People are remarkably resilient.

9. We see the world as it is.

We are not passive recipients of external information that enters our brain through our sensory organs. Instead, we actively search for patterns (like a Dalmatian dog that suddenly appears in a field of black and white dots), turn ambiguous scenes into ones that fit our expectations (it's a vase; it's a face) and completely miss details we aren't expecting. In one famous psychology experiment, about half of all viewers told to count the number of times a group of people pass a basketball do not notice that a guy in a gorilla suit is hulking around among the ball-throwers.

We have a limited ability to pay attention (which is why talking on a cellphone while driving can be as dangerous as drunk driving), and plenty of biases about what we expect or want to see. Our perception of the world isn't just "bottom-up"—built of objective observations layered together in a logical way. It's "top-down," driven by expectations and interpretations.

10. Men are from Mars, women are from Venus.

Some of the sloppiest, shoddiest, most biased, least reproducible, worst designed and most overinterpreted research in the history of science purports to provide biological explanations for differences between men and women. Eminent neuroscientists once claimed that head size, spinal ganglia or brain stem structures were responsible for women's inability to think creatively, vote logically or practice medicine. Today the theories are a bit more sophisticated: men supposedly have more specialized brain hemispheres, women more elaborate emotion circuits. Though there are some differences (minor and uncorrelated with any particular ability) between male and female brains, the main problem with looking for correlations with behavior is that sex differences in cognition are massively exaggerated.

Women are thought to outperform men on tests of empathy. They do—unless test subjects are told that men are particularly good at the test, in which case men perform as well as or better than women. The same pattern holds in reverse for tests of spatial reasoning. Whenever stereotypes are brought to mind, even by something as simple as asking test subjects to check a box next to their gender, sex differences are exaggerated. Women college students told that a test is something women usually do poorly on, do poorly. Women college students told that a test is something college students usually do well on, do well. Across countries—and across time—the more prevalent the belief is that men are better than women in math, the greater the difference in girls' and boys' math scores. And that's not because girls in Iceland have more specialized brain hemispheres than do girls in Italy.

Certain sex differences are enormously important to us when we're looking for a mate, but when it comes to most of what our brains do most of the time—perceive the world, direct attention, learn new skills, encode memories, communicate (no, women don't speak more than men do), judge other people's emotions (no, men aren't inept at this)—men and women have almost entirely overlapping and fully Earth-bound abilities.

Find this article at:

http://www.smithsonianmag.com/science-nature/Top-Ten-Myths-About-the-Brain.html

Gobekli Tepe: The World's First Temple?
Predating Stonehenge by 6,000 years, Turkey's stunning Gobekli Tepe upends the conventional view of the rise of civilization

Now seen as early evidence of prehistoric worship, the hilltop site was previously shunned by researchers as nothing more than a medieval cemetery.

- By Andrew Curry
- Photographs by Berthold Steinhilber
- *Smithsonian* magazine, November 2008

Six miles from Urfa, an ancient city in southeastern Turkey, Klaus Schmidt has made one of the most startling archaeological discoveries of our time: massive carved stones about 11,000 years old, crafted and arranged by prehistoric people who had not yet developed metal tools or even pottery. The megaliths predate Stonehenge by some 6,000 years. The place is called Gobekli Tepe, and Schmidt, a German archaeologist who has been working here more than a decade, is convinced it's the site of the world's oldest temple.
"Guten Morgen," he says at 5:20 a.m. when his van picks me up at my hotel in Urfa. Thirty minutes later, the van reaches the foot of a grassy hill and parks next to strands of barbed wire. We follow a knot of workmen up the hill to rectangular pits shaded by a corrugated steel roof—the main excavation site. In the pits, standing stones, or pillars, are arranged in circles. Beyond, on the hillside, are four other rings of partially excavated pillars. Each ring has a roughly similar layout: in the center are two large stone T-shaped pillars encircled by slightly smaller stones facing inward. The tallest pillars tower 16 feet and, Schmidt says, weigh between seven and ten tons. As we walk among them, I see that some are blank, while others are elaborately carved: foxes, lions, scorpions and vultures abound, twisting and crawling on the pillars' broad sides.
Schmidt points to the great stone rings, one of them 65 feet across. "This is the first human-built holy place," he says.
From this perch 1,000 feet above the valley, we can see to the horizon in nearly every direction. Schmidt, 53, asks me to imagine what the landscape would have looked like 11,000 years ago, before centuries of intensive farming and settlement turned it into the nearly featureless brown expanse it is today.
Prehistoric people would have gazed upon herds of gazelle and other wild animals; gently flowing rivers, which attracted migrating geese and ducks; fruit and nut trees; and rippling fields of wild barley and wild wheat varieties such as emmer and einkorn. "This area was like a paradise," says Schmidt, a member of the

German Archaeological Institute. Indeed, Gobekli Tepe sits at the northern edge of the Fertile Crescent—an arc of mild climate and arable land from the Persian Gulf to present-day Lebanon, Israel, Jordan and Egypt—and would have attracted hunter-gatherers from Africa and the Levant. And partly because Schmidt has found no evidence that people permanently resided on the summit of Gobekli Tepe itself, he believes this was a place of worship on an unprecedented scale—humanity's first "cathedral on a hill."

With the sun higher in the sky, Schmidt ties a white scarf around his balding head, turban-style, and deftly picks his way down the hill among the relics. In rapid-fire German he explains that he has mapped the entire summit using ground-penetrating radar and geomagnetic surveys, charting where at least 16 other megalith rings remain buried across 22 acres. The one-acre excavation covers less than 5 percent of the site. He says archaeologists could dig here for another 50 years and barely scratch the surface.

Gobekli Tepe was first examined—and dismissed—by University of Chicago and Istanbul University anthropologists in the 1960s. As part of a sweeping survey of the region, they visited the hill, saw some broken slabs of limestone and assumed the mound was nothing more than an abandoned medieval cemetery.

In 1994, Schmidt was working on his own survey of prehistoric sites in the region. After reading a brief mention of the stone-littered hilltop in the University of Chicago researchers' report, he decided to go there himself. From the moment he first saw it, he knew the place was extraordinary.

Unlike the stark plateaus nearby, Gobekli Tepe (the name means "belly hill" in Turkish) has a gently rounded top that rises 50 feet above the surrounding landscape. To Schmidt's eye, the shape stood out. "Only man could have created something like this," he says. "It was clear right away this was a gigantic Stone Age site." The broken pieces of limestone that earlier surveyors had mistaken for gravestones suddenly took on a different meaning.

Schmidt returned a year later with five colleagues and they uncovered the first megaliths, a few buried so close to the surface they were scarred by plows. As the archaeologists dug deeper, they unearthed pillars arranged in circles. Schmidt's team, however, found none of the telltale signs of a settlement: no cooking hearths, houses or trash pits, and none of the clay fertility figurines that litter nearby sites of about the same age. The archaeologists did find evidence of tool use, including stone hammers and blades. And because those artifacts closely resemble others from nearby sites previously carbon-dated to about 9000 B.C., Schmidt and co-workers estimate that Gobekli Tepe's stone structures are the same age. Limited carbon dating undertaken by Schmidt at the site confirms this assessment.

The way Schmidt sees it, Gobekli Tepe's sloping, rocky ground is a stonecutter's dream. Even without metal chisels or hammers, prehistoric masons wielding flint tools could have chipped away at softer limestone outcrops, shaping them into pillars on the spot before carrying them a few hundred yards to the summit and lifting them upright. Then, Schmidt says, once the stone rings were finished, the ancient builders covered them over with dirt. Eventually, they placed another ring nearby or on top of the old one. Over centuries, these layers created the hilltop.

Today, Schmidt oversees a team of more than a dozen German archaeologists, 50 local laborers and a steady stream of enthusiastic students. He typically excavates at the site for two months in the spring and two in the fall. (Summer temperatures reach 115 degrees, too hot to dig; in the winter the area is deluged by rain.) In 1995, he bought a traditional Ottoman house with a courtyard in Urfa, a city of nearly a half-million people, to use as a base of operations.

On the day I visit, a bespectacled Belgian man sits at one end of a long table in front of a pile of bones. Joris Peters, an archaeozoologist from the Ludwig Maximilian University in Munich, specializes in the analysis of animal remains. Since 1998, he has examined more than 100,000 bone fragments from Gobekli Tepe. Peters has often found cut marks and splintered edges on them—signs that the animals from which they came were butchered and cooked. The bones, stored in dozens of plastic crates stacked in a storeroom at the house, are the best clue to how people who created Gobekli Tepe lived. Peters has identified tens of thousands of gazelle bones, which make up more than 60 percent of the total, plus those of other wild game such as boar, sheep and red deer. He's also found bones of a dozen different bird species, including vultures, cranes, ducks and geese. "The first year, we went through 15,000 pieces of animal bone, all of them wild. It was pretty clear we were dealing with a hunter-gatherer site," Peters says. "It's been the same every year since." The abundant remnants of wild game indicate that the people who lived here had not yet domesticated animals or farmed.

But, Peters and Schmidt say, Gobekli Tepe's builders were on the verge of a major change in how they lived,

thanks to an environment that held the raw materials for farming. "They had wild sheep, wild grains that could be domesticated—and the people with the potential to do it," Schmidt says. In fact, research at other sites in the region has shown that within 1,000 years of Gobekli Tepe's construction, settlers had corralled sheep, cattle and pigs. And, at a prehistoric village just 20 miles away, geneticists found evidence of the world's oldest domesticated strains of wheat; radiocarbon dating indicates agriculture developed there around 10,500 years ago, or just five centuries after Gobekli Tepe's construction.

To Schmidt and others, these new findings suggest a novel theory of civilization. Scholars have long believed that only after people learned to farm and live in settled communities did they have the time, organization and resources to construct temples and support complicated social structures. But Schmidt argues it was the other way around: the extensive, coordinated effort to build the monoliths literally laid the groundwork for the development of complex societies.

The immensity of the undertaking at Gobekli Tepe reinforces that view. Schmidt says the monuments could not have been built by ragged bands of hunter-gatherers. To carve, erect and bury rings of seven-ton stone pillars would have required hundreds of workers, all needing to be fed and housed. Hence the eventual emergence of settled communities in the area around 10,000 years ago. "This shows sociocultural changes come first, agriculture comes later," says Stanford University archaeologist Ian Hodder, who excavated Catalhoyuk, a prehistoric settlement 300 miles from Gobekli Tepe. "You can make a good case this area is the real origin of complex Neolithic societies."

What was so important to these early people that they gathered to build (and bury) the stone rings? The gulf that separates us from Gobekli Tepe's builders is almost unimaginable. Indeed, though I stood among the looming megaliths eager to take in their meaning, they didn't speak to me. They were utterly foreign, placed there by people who saw the world in a way I will never comprehend. There are no sources to explain what the symbols might mean. Schmidt agrees. "We're 6,000 years before the invention of writing here," he says. "There's more time between Gobekli Tepe and the Sumerian clay tablets [etched in 3300 B.C.] than from Sumer to today," says Gary Rollefson, an archaeologist at Whitman College in Walla Walla, Washington, who is familiar with Schmidt's work. "Trying to pick out symbolism from prehistoric context is an exercise in futility."

Still, archaeologists have their theories—evidence, perhaps, of the irresistible human urge to explain the unexplainable. The surprising lack of evidence that people lived right there, researchers say, argues against its use as a settlement or even a place where, for instance, clan leaders gathered. Hodder is fascinated that Gobekli Tepe's pillar carvings are dominated not by edible prey like deer and cattle but by menacing creatures such as lions, spiders, snakes and scorpions. "It's a scary, fantastic world of nasty-looking beasts," he muses. While later cultures were more concerned with farming and fertility, he suggests, perhaps these hunters were trying to master their fears by building this complex, which is a good distance from where they lived.

Danielle Stordeur, an archaeologist at the National Center for Scientific Research in France, emphasizes the significance of the vulture carvings. Some cultures have long believed the high-flying carrion birds transported the flesh of the dead up to the heavens. Stordeur has found similar symbols at sites from the same era as Gobekli Tepe just 50 miles away in Syria. "You can really see it's the same culture," she says. "All the most important symbols are the same."

For his part, Schmidt is certain the secret is right beneath his feet. Over the years, his team has found fragments of human bone in the layers of dirt that filled the complex. Deep test pits have shown that the floors of the rings are made of hardened limestone. Schmidt is betting that beneath the floors he'll find the structures' true purpose: a final resting place for a society of hunters.

Perhaps, Schmidt says, the site was a burial ground or the center of a death cult, the dead laid out on the hillside among the stylized gods and spirits of the afterlife. If so, Gobekli Tepe's location was no accident. "From here the dead are looking out at the ideal view," Schmidt says as the sun casts long shadows over the half-buried pillars. "They're looking out over a hunter's dream."

Andrew Curry, who is based in Berlin, wrote the July cover story about Vikings.

Berthold Steinhilber's hauntingly lighted award-winning photograhs of American ghost towns appeared in *Smithsonian* in May 2001.

Find this article at:
http://www.smithsonianmag.com/history-archaeology/gobekli-tepe.html

Did Archaeologists Uncover Blackbeard's Treasure?

Cannons. Gold dust. Turtle bones. For archaeologists researching the notorious pirate's flagship, every clue is priceless

Archaeologists have been recovering historical artifacts from the vessel possibly stolen by Blackbeard since 1996.

- *Smithsonian* magazine, March 2011

The vessel believed to have been Blackbeard's flagship is currently occupied by octopuses, which turn a pale, disgruntled green when nautical archaeologists approach. Black sea bass nip at the excavators' ears, and moray eels spill out of the mouths of cannons, many of which are still loaded.

But after nearly 300 years in the North Carolina shallows, the remains of what may be the *Queen Anne's Revenge* are surfacing, plank by worm-eaten plank. The site, discovered in 1996, is 25 feet underwater, less than a mile and a half from shore. But long weather delays during diving seasons and uncertain funding have slowed the excavation—this past fall's expedition was the first since 2008—and it can take years to clean and analyze artifacts corroded beyond recognition. Still, with objects recovered from 50 percent of the site, archaeologists are increasingly confident that the wreck is the infamous frigate that terrorized the Caribbean and once blockaded Charleston, South Carolina, for a week before running aground in June 1718.

"We're not going to find anything that says 'Queen Anne's Revenge' or 'Blackbeard Was Here,'" says Wendy Welsh, manager of the state-run Queen Anne's Revenge Conservation Laboratory in Greenville, North Carolina. "You have to use all these little clues."

Mike Daniel, the sea captain who first located the ship, introduced me to Welsh. Daniel is a successful treasure hunter who, in 1972, helped find *Nuestra Señora de las Maravillas*—a gold- and gem-laden Spanish galleon that sank off the Bahamas in 1656. But it was Welsh who most evoked the persona of a pirate, wearing skull and crossbones earrings and a galleon-like charm around her neck. She stormed through the lab, peeling tarps off cannons with such ardor that Blackbeard might have welcomed her aboard.

The heavily corroded cannons—some eight feet long and meant to spit six-pound cannonballs—were soaking in various chemical baths to restore them, a process that takes roughly five years. Some cannons that hadn't undergone chemical treatment were barely recognizable. When a metal artifact corrodes underwater, sand, seashells and other objects adhere to its sides—which then provide attachment points for marine life, such as barnacles. These outer layers, which grow thicker over time, are known as "concretions." Before breaking

them apart, lab workers try to identify what lies beneath with X-rays, but some objects are undetectable. If technicians aren't careful while cleaning the concretions with air scribes—a type of mini-jackhammer—valuable pieces can be destroyed, especially small ones.
"Once you touch a glass bead, it shatters, and you're done," Welsh says.
"Same thing happens with emeralds," Daniel says.
"I wouldn't know," Welsh says a bit wistfully.
Except for a sprinkling of gold dust—less than one ounce so far—no treasure has been found aboard the vessel likely piloted by Edward Teach, the British-born pirate known as Blackbeard. According to 18th-century depositions, Blackbeard—named for his impressive facial hair, which he styled in braids—seized his best and biggest warship from French slave traders in 1717, one hundred miles off Martinique. Capable of carrying about 300 tons and armed with 16 cannons, the vessel carried hundreds of slaves and 20 pounds of gold dust. It was called *La Concorde*, but Blackbeard, who'd served the crown in Queen Anne's War against France (1702-13) before going into business for himself, promptly renamed his prize in honor of the English monarch. After offloading most of the slaves and the captured crew, and relieving them of their gold, Blackbeard spent months marauding in the Caribbean, acquiring a miniature navy of smaller boats and amassing a huge crew.
In May 1718, the *Queen Anne's Revenge* blockaded the port of Charleston, holding prominent citizens hostage in return for a chest of medicine. After collecting the ransom, Blackbeard retreated to North Carolina, which had plenty of hiding spots in obscure coves and inlets behind the Outer Banks. Alas, in early June, as Blackbeard and his fleet advanced on the sleepy fishing village of Beaufort, North Carolina, the *Queen Anne's Revenge* foundered on a sandbar.
The details of how the ship ran aground remain a matter of dispute. Some experts believe Blackbeard was just another victim of the treacherous sandbanks at the mouth of Beaufort inlet, which tend to shift during storms, confounding even modern captains. Others, however, think Blackbeard deliberately abandoned the ship, which was far too large to navigate North Carolina's shallow sounds, in an effort to downsize his crew (some of whom later testified as much) and travel light, transferring his treasure to the smaller ships in his fleet. Whatever the scenario, the demise of the *Queen Anne's Revenge* was what archaeologists call a "nonviolent wreck event," meaning that the pirates had ample time to offload plunder.
Luckily, the archaeologists have a different notion of treasure. They've found hundreds of historical objects including a diminutive signal gun, turtle bones (possible remnants of a favorite pirate food), a pewter syringe, a funnel-shaped spout that served as a urinal and an intact piece of window glass, blue-green and rippling like a sculpture of the sea. The 2010 dive yielded an ornate sword hilt made of iron, copper and an animal horn or antler.
The trouble is, none of these proves the ship's identity. Though the datable artifacts can be traced to the decades before the vessel's sinking (any dates after June 1718 would be powerful evidence against the ship's claim to fame), so far there is nothing conclusive.
By contrast, the wreck of the *Whydah Galley*, the best-established American pirate ship, which sank in a storm off Massachusetts in 1717, yielded a bell inscribed with the ship's name. Without a similar trophy, it's challenging to make an airtight case that Daniel's discovery is the *Queen's Anne's Revenge*. "We're trying to get into the minds of piratical characters from 300 years ago with limited historical and archaeological evidence," says David Moore, an archaeologist with the North Carolina Maritime Museum, in Beaufort, where many of the wreck's artifacts are on display. But the clues keep mounting.
First, there's the general location of the wreck, which is consistent with the historical accounts and antique maps that Daniel used in his search. "In the world of shipwrecks, our basic philosophy is that it is where it's supposed to be," he says. "Here's the sandbar, here's the channel coming in, and in that channel sits the *QAR*." Then there's the sheer size of the three-masted ship, which would have made it an unusual, if not unique, visitor to the little-traveled Beaufort inlet. The boat was also armed to the teeth—excavators have recovered some 225,000 pieces of lead shot and identified at least 25 cannons (though *La Concorde* carried only 16, the pirates would likely have added some of their own). The guns were apparently kept loaded at all times, a typical scofflaw practice. And then there's the stuff with which they were loaded. At least one has iron bolts in its bore, and there are other suggestions of deck-clearing ammunition, like the remains of canvas bags full of broken glass, nails and other shrapnel. "A proper Englishman would not do that," says Jim Craig, the head geologist for the project. "But a pirate is a pirate and he does anything he wants."

Researchers are also finding potential links to the ship's past as a French slaver. Manacle-like restraints and glass beads of the sort frequently traded in Africa have been recovered. Divers siphoning sediment from the wreck site have found dustings of gold that might have been part of *La Concorde's* cargo. Archaeologists have salvaged several objects inscribed with fleurs-de-lis—a symbol that was often, though not exclusively, associated with France.

But since pirates acquired loot from everywhere, the best clues may be in the bones of the ship itself. There isn't much timber left to examine, since wood that isn't buried deteriorates in salt water. Fortunately, part of the vessel remained covered in sand. When the team recovered a 3,000-pound piece of the stern, they found two draft marks meant to show how much of the vessel was below the waterline. While such measurements were vital to navigation, this ship's seem curiously off—there are 12.75 inches in between the markings, as opposed to a standard foot. But, Moore realized, 12.75 inches was the French measurement for a foot at that time.

The most compelling argument *against* the shipwreck being Blackbeard's is found on a cannon barrel marked rather crudely with three very large numbers–1,7,3–and a slightly smaller 0. If these numbers signify a date, 1730, it would be the death knell for the Blackbeard theory. But researchers say the figure more likely refers to an antiquated weight system or perhaps a catalog number.

Blackbeard lived only six months after the abandonment of the *Queen Anne's Revenge*; a Royal Navy lieutenant from Virginia ambushed him at sea and sailed home with the pirate's head dangling from his bowsprit. The pirate's legend, though, swashbuckles on. His popular exhibit at the North Carolina Maritime Museum is soon to be supplemented with dozens of never-before-seen artifacts, and Blackbeard—played by Ian McShane—and the *Queen Anne's Revenge* will both be resurrected in the latest *Pirates of the Caribbean* film, *On Stranger Tides*, due out this spring.

Meanwhile, archaeologists are itching to start work on the largest concretion of all: a huge pile of cannons and anchors still on the seafloor. They hope the mound is big enough to contain preserved material for micro-organic analysis. Bits of food, sediment or insect parts could tie the ship to the Caribbean or Africa. Or perhaps they'll just discover "some hooks and wooden legs," jokes Mark Wilde-Ramsing, a state archaeologist working on the project. "Parrot bones, maybe."

Staff writer **Abigail Tucker** last wrote about lynx in the February issue.

Find this article at:
http://www.smithsonianmag.com/history-archaeology/Did-Archaeologists-Uncover-Blackbeards-Treasure.html

A New View Into California's Kelp Forests

Scientists use satellite images of the kelp canopy (here, as seen from underwater) to track this important ecosystem over time (Credit: Stuart Halewood)

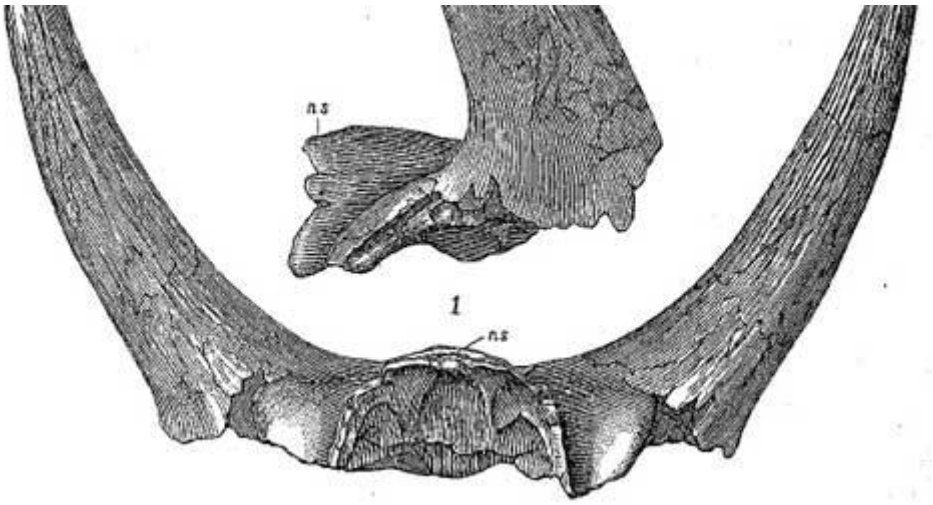
I remember an analogy from one of my marine science classes, that studying the ocean is sometimes like trying to study a forest by dropping a bucket from a helicopter. It explains why we know comparatively little about ocean ecosystems, even when they're situated close to populous areas of land, like the forests of giant kelp (*Macrocystis pyrifera*) in the Santa Barbara Channel off California. These kelp ecosystems are important because they provide food and habitat for a variety of fish and other species. And now a group of scientists led by the University of California, Santa Barbara found a new way to study the kelp, which enabled them to look at long-term changes in this ecosystem for the first time. (Their results appear in *Marine Ecology Progress Series*.)

The scientists were able to use images of the area made by the Landsat 5 satellite from 1984 through 2009. (Scientists were not previously able to use the extensive collection of imagery because of the cost; in 2009, Landsat images were made freely available.) "Giant kelp forms a dense floating canopy at the sea surface that's distinctive when viewed from above," the researchers wrote. They used the imagery to document the changes in the kelp forests over time and found that, during most years, the forests go through an annual cycle, rapidly growing in spring and summer and dying back during the winter. In some regions, huge waves limit the kelp's growth, while in others they are held back by a lack of nutrients.

"We know from scuba observations that individual kelp plants are fast-growing and short-lived," says study co-author Kyle Cavanaugh of UCSB. "The new data show the patterns of variability that are also present within and among years at much larger spatial scales. Entire kelp forests can be wiped out in days, then recover in a matter of months."

http://blogs.smithsonianmag.com/science/2011/05/a-new-view-into-californias-kelp-forests/

When Triceratops Was a Giant Bison



The horns of Marsh's Bison alticornis, now recognized as those of a ceratopsian dinosaur. Image from Wikipedia.

Triceratops—the giant with a "three-horned face"—is one of the great ambassadors for dinosaurs. Everyone knows this well-ornamented Cretaceous herbivore today, but the dinosaur was originally mistaken for a very different creature. For a short time, the horns of *Triceratops* were thought to belong to a giant bison.

Near the close of the 19th century, relatively little was known about the dinosaurs of North America (or, in fact, dinosaurs in general). The word "dinosaur" had been coined by the English anatomist Richard Owen in 1842, and the entire group was only represented by a handful of species known from specimens of varying completeness. The extraordinary fossil-rich formations of the American West had just begun to be examined, meaning each discovery had the potential to significantly change the image of prehistoric life. The early *Triceratops* fossil was one such discovery.

The story of the fossil—including its changing attribution—was retold by paleontologist Ken Carpenter in a 2007 paper in the book *Horns and Beaks*. The tale of the specimen began in the rock around Denver, Colorado. This area was peppered with fossils from the last days of the dinosaurs and the earliest days of the post-dinosaur world, and the fossils were so accessible that many were picked up by local collectors and those in want of natural curiosities to display at home.

But the *Triceratops* fossil had a different fate. In the spring of 1887, a local high school teacher and geologist by the name of George Cannon found two large horns and part of a skull roof. The specimen was sent to Othniel Charles Marsh at Yale University, and after urging his contacts in the field that he wanted more of the skull, a few more fragments of the horns soon followed. Altogether, the fossil consisted of a pair of long horns attached to part of the skull roof, and it had clearly belonged to some prehistoric animal much larger than anything that roamed the West in modern times.

Anatomically speaking, the horns most closely resembled those of herbivorous, horn-bearing mammals like bison. In fact, the horns looked as if they had come from some gigantic predecessor of that iconic Western symbol, and therefore Marsh named this new creature "*Bison alticornis*" that same year. Those who know the rocks from which the bones came were not so sure. Cannon, who had found other dinosaur fossils in the same rock layers, found it strange that the remains of a giant bison should be found mixed in with those of dinosaurs, and he wrote to Marsh that he would devote every spare second to figuring out why such disparate organisms should be found in the same strata.

Marsh eventually recognized the Denver horns as belonging to a horned dinosaur, but his path to this conclusion was circuitous. For example, in 1888 Marsh named the dinosaur *Ceratops* on the basis of similar, smaller horns that had been sent to him, but the Yale paleontologist initially thought the horns were spikes akin to those anchored in the tail of *Stegosaurus*. (Another dinosaur that Marsh changed his mind about multiple times.) Marsh changed his stance again after receiving the partial skull of the dinosaur that he would

name *Triceratops horridus* in 1889 —the long, pointed structures were horns peculiar to this previously unrecognized group of dinosaurs, and further discoveries of horned dinosaurs reinforced this view. (Marsh's nemesis, Edward Drinker Cope, had studied a number of horned dinosaur specimens during the 1870s, but he was also left puzzled by the horn cores and other incomplete remains from the ceratopsians.) Still, to cover his mistake, Marsh affirmed that the structure of the Denver horns truly was similar to that of a bison. This isn't so far-fetched. The horn structures of *Triceratops* and bison are somewhat similar, and paleontologist Tobin Hieronymus and colleagues recently used the horn anatomy of buffalo and musk oxen to reconstruct the facial structures of the horned dinosaur *Pachyrhinosaurus*.

As Carpenter cautions, though, we should not ridicule Marsh for his mistakes. No one in the late 1880s knew what a ceratopsian really looked like, especially since many of the dinosaurs that Marsh had previously studied were Jurassic creatures that lived many millions of years before. With nothing else for comparison, the *Triceratops* horns did show some features in common with both bison horns and *Stegosaurus* spikes, which led Marsh to incorrect conclusions until more complete specimens finally solved the mystery. Marsh's mistakes are a prime example of how new dinosaurs are sometimes identified—parts of unknown creatures are compared to what is already known in an attempt to narrow down a range of possibilities for identification. *Triceratops* was so different from other dinosaurs Marsh studied that it is little wonder that he erred in his conclusions. Who could have imagined an animal as magnificent as *Triceratops* on the basis of the horns alone?

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http://blogs.smithsonianmag.com/dinosaur/2011/05/when-triceratops-was-a-giant-bison/

An Unforgettable Photo of Martha Graham

Barbara Morgan's portrait of the iconic dancer helped move modern dance to center stage

Barbara Morgan's portrait of Martha Graham may be the most famous photo ever taken of an American dancer

By Joan Acocella

- *Smithsonian* magazine, June 2011

Barbara Morgan's 1940 image of Martha Graham in the ballet *Letter to the World* may be the most famous photograph ever taken of an American dancer. It ranks, in honor, with Ansel Adams' photographs of Yosemite and Walker Evans' of small-town churches, and it bears much the same message: Americans' belief in the flinty, frank truth of their vision of life, as opposed, say, to European decorativeness and indirection. That faith was especially strong around the mid-20th century, and in the minds of certain artists it was allied especially with the American Southwest: the hogans, the cliff-hemmed mesas, the vaulted skies. D.H. Lawrence and (the best-known example) Georgia O'Keeffe lived there. Many others traveled there, including the California photographer Barbara Morgan.

Born in 1900, Morgan worked in several media—printmaking, drawing, watercolor—but by the mid-'30s she was concentrating on photography, partly because it was easier to do with two children in the house. In the summers, she and her husband, Willard, a writer and photographer (he would be the first director of photography at New York City's Museum of Modern Art), visited the Southwest and turned their cameras on the landscape. Another devotee of that part of the country was the dancer and choreographer Martha Graham. Graham, born in 1894, first visited the Southwest in 1930. The place hit her like a brick, and confirmed her quest for an austere and ritualistic style.

Thus when Graham and Morgan met, in 1935, they found they had a shared interest. Indeed, they had much in common. Both were dedicated modernists and hence, at that time in America, bohemians, iconoclasts. In addition, both were highly idealistic, given to pronouncements on the Spirit, the Essence and so forth. According to the philosopher Curtis Carter, a friend of Morgan's who has curated three exhibitions of her work and written most of what we know about her, Morgan had first seen Graham's work several years earlier. We don't know if Graham had seen Morgan's work, but apparently she sensed a kinship. Within a

short time Morgan proposed to do a book of photographs of Graham, and the choreographer said, “Fine, let’s do it.”

It was not an easy project. “She was a terror,” Graham told an interviewer years later. “I’d do it, and then she’d say, ‘Well, the dress wasn’t quite right,’ and then we’d have to do it again. First she would make me lie down on the floor and rest. So off came the dress (it mustn’t get dirty, you know), and then we’d start all over again.” Morgan had her reasons—exalted ones, as usual: “I wanted to show that Martha had her own vision,” she said about the photo shoots. “That what she was conveying was deeper than ego, deeper than baloney. Dance has to go beyond theater....I was trying to connect her spirit with the viewer—to show pictures of spiritual energy.” Graham probably agreed. In the book Morgan finally produced in 1941, *Martha Graham: Sixteen Dances in Photographs*—which contained the *Letter to the World* image—Graham writes, “Every true dancer has a peculiar arrest of movement, an intensity which animates his whole being. It may be called Spirit, or Dramatic Intensity, or Imagination.”

Nowadays, these words sound a little high-flown, as do many writings of the period (think of Eugene O’Neill or Tennessee Williams), but the combined ardor of Graham and Morgan produced what—with maybe one competitor, George Platt Lynes’ images of George Balanchine’s early work—were the greatest dance photographs ever made in America. Morgan thought she was just celebrating Graham. In fact, she was celebrating dance, an art often condescended to. The composition of the photograph is beautiful—the horizontal line of the torso echoing that of the floor, the arc of the kick answering the bend of the arm to the forehead—but this is more than a composition. It is a story. *Letter to the World* is about Emily Dickinson, who spent her life shut up in her family’s house in Amherst and who nevertheless, on the evidence of her poetry, experienced in those confines every important emotion known to humankind. Graham’s dance was accompanied by readings from Dickinson, including:

Of Course—I prayed—
And did God Care?
He cared as much as on the Air
A bird—had stamped her foot—
And cried “Give me!”—

Unanswered prayers: most people know what that means. Hence the seismic power of the photograph.

Both Morgan and Graham lived to be very old, Morgan to 92, Graham to 96. Graham became this country’s most revered homegrown choreographer. She, more than anyone else, is now considered the creator of American modern dance. Twenty years after her death, her company is still performing. Morgan’s reputation remained more within the photographic and dance communities. By the late 1970s, her book was out of print (old copies were selling for $500) and it was often stolen from libraries. But it was reprinted in 1980.

Joan Acocella is the dance critic for the *New Yorker*.

Find this article at:
http://www.smithsonianmag.com/arts-culture/An-Unforgettable-Photo-of-Martha-Graham.html

Where Agatha Christie Dreamed Up Murder

The birthplace of Poirot and Marple welcomes visitors looking for clues to the best-selling novelist of all time

- By Joshua Hammer
- Photographs by Michael Freeman
- *Smithsonian* magazine, June 2011

Christie purchased Greenway in 1938. Years later, she recalled the spell that the estate had cast on her: "a white Georgian house of about 1780 or '90, with woods sweeping down to the Dart...the ideal house, a dream house."
Michael Freeman

On a crisp winter morning in Devon, England, sunlight streams through the floor-to-ceiling French windows of the manor house called Greenway, the secluded estate where Agatha Christie spent nearly every summer from 1938 until her death in 1976—and which opened to the public in February 2009. Gazing beyond a verdant lawn through bare branches of magnolia and sweet-chestnut trees, I glimpse the River Dart, glinting silver as it courses past forested hills. Robyn Brown, the house's manager, leads me into the library. Christie's reading chair sits by the window; a butler's tray holds bottles of spirits; and a frieze depicting World War II battle scenes—incongruous in this tranquil country retreat—embellishes the cream-colored walls. It was painted in 1944 by Lt. Marshall Lee, a U.S. Coast Guard war artist billeted here with dozens of troops after the British Admiralty requisitioned the house. "The Admiralty came back after the war and said, 'Sorry about the frieze in the library. We'll get rid of it,'" Brown tells me. "Agatha said, 'No, it's a piece of history. You can keep it, but please get rid of the [14] latrines.'"
Agatha Christie was 48 years old in 1938, gaining fame and fortune from her prolific output of short stories and novels, one series starring the dandified Belgian detective Hercule Poirot, another centered on the underestimated spinster-sleuth Jane Marple. Christie's life had settled into a comfortable routine: part of the year was spent at her house in Wallingford, near Oxford, and part on excavations in the deserts of Iraq and Syria with her second husband, archaeologist Max Mallowan. But Christie longed for a vacation refuge. That summer, she heard of a handsome Georgian manor house, built around 1792, going up for sale; it was set on

33 acres, 15 miles from her birthplace, the village of Torquay. For Christie, Greenway—reachable only by boat or down a narrow country lane one and a half miles from the nearest village of Galmpton—represented, as she wrote in her autobiography, "the ideal house, a dream house." The estate's owner, financially strapped by the Great Depression, offered it for just £6,000—the equivalent of about $200,000 today. Christie snapped it up.

Here, the author and playwright could escape from her growing celebrity and enjoy the company of friends and family: her only child, Rosalind Hicks; son-in-law Anthony Hicks; and grandson Mathew Prichard, whose father, Rosalind's first husband, Hubert Prichard, had been killed in the 1944 Allied invasion of France. Greenway served as the inspiration for several scenes in Christie's murder mysteries, including the Poirot novels *Five Little Pigs* (1942) and *Dead Man's Folly* (1956).

After Christie died, at age 85, the estate passed to Hicks and her husband. Shortly before their own deaths in 2004 and 2005, respectively, the couple donated the property to Britain's National Trust, the foundation that grants protected status to historic houses, gardens and ancient monuments and opens the properties to the public.

Brown recalls several meetings with the frail but alert 85-year-old Rosalind, whose failing health required her to move around the house by mobility scooter. At one of them, Brown broached the subject of Greenway's future. "The sticking point for Rosalind was that she didn't want us to create a tacky enterprise—the 'Agatha Christie Experience,'" Brown told me. Indeed, Hicks first demanded that the house be stripped bare before she would donate it. "If we show the rooms empty, the house will have no soul," Brown recalled telling Rosalind. "If we bring things in from outside, it will be contrived." Brown proposed that the house be left "as though you and Anthony just walked out the door." Eventually, Rosalind agreed.

In 2009, after a two-year, $8.6 million renovation—"the house was in terrible shape," says Brown—Greenway opened to the public. During the first eight-month season, it attracted 99,000 visitors, an average of 500 a day, nearly double expectations. Today, Greenway offers an opportunity to view the intimate world of a reclusive literary master, who rarely gave interviews and shunned public appearances. "She was hugely shy, and this was her place of solitude, comfort and quiet," Brown says. Greenway "represents the informal, private side of Agatha Christie, and we have striven to retain that atmosphere."

Greenway's success is the latest, most visible sign of the extraordinary hold that Agatha Christie continues to exert nearly 35 years after her death. Her 80 detective novels and 18 short-story collections, plus the romances written under the pseudonym Mary Westmacott, have sold two billion copies in more than 50 languages—making her by far the most popular novelist of all time. Her books sell four million copies annually and earn millions of dollars a year for Agatha Christie Limited, a private company of which 36 percent is owned by Mathew Prichard and his three children, and for Chorion Limited, the media company that bought a majority stake in 1998. A stream of dramatized Poirot and Miss Marple whodunits continue to appear as televised series. A new version of *Murder on the Orient Express*, starring David Suchet, who plays Poirot on public television in the United States, aired in this country last year. Meanwhile, Christie's *Mousetrap*—a thriller centered on guests snowed in at a country hotel—is still in production at the St. Martins Theatre in London's West End; the evening I saw it marked performance number 23,774 for the longest-running play in history.

Every year, tens of thousands of Christie's admirers descend on Torquay, the Devon resort where the author spent her early years. They walk the seafront "Agatha Christie Mile" ("A Writer's Formative Venue,") that delineates landmarks of her life, from the Victorian pier, where the teenage Agatha roller-skated on summer weekends, to the Grand Hotel, where she spent her wedding night with her first husband, Royal Flying Corps aviator Archie Christie, on Christmas Eve 1914. The annual Christie Festival at Torquay draws thousands of devotees, who attend murder-mystery dinners, crime-writing workshops and movie screenings and have been known to dress as Hercule Poirot look-alikes.

And Christie's own story is still unfolding: in 2009, HarperCollins published *Agatha Christie's Secret Notebooks*, an annotated selection of her jottings, unearthed at Greenway in 2005 before renovations began there. The cache provided new insight into her creative process. "There are notes for a single novel scattered over a dozen notebooks," says John Curran, a Christie scholar at Trinity College Dublin, who discovered the 73 notebooks after he had been invited to Greenway by grandson Mathew Prichard. "At her peak, her brain just teemed with ideas for books, and she scribbled them down any way she could." The book also includes a never-before-seen version of a short story written in late 1938, "The Capture of Cerberus," featuring a Hitler-

like archvillain. Earlier in 2009, a research team from the University of Toronto caused an international tempest with its report suggesting that she had suffered from Alzheimer's disease during her final years.

The restoration of Greenway has also catalyzed a reappraisal of Christie's work. Journalists and critics visited Devon in droves when the estate opened, pondering the novelist's enduring popularity. Some critics complain that, in contrast to such masters of the form as Arthur Conan Doyle, creator of Sherlock Holmes, or Georges Simenon, the Belgian-born author of the Inspector Maigret series, Christie was neither a prose stylist nor a creator of fully realized characters. "Her use of language is rudimentary and her characterizations thin," Barry Forshaw, editor of *British Crime Writing: An Encyclopedia*, recently opined in the *Independent* newspaper. Christie set her novels in "a never-never-land Britain, massively elitist," he declared; her detectives amounted to "collections of tics or eccentric physical characteristics, with nothing to match the rich portrayal of the denizen of 221B Baker Street." To be sure, Poirot lacks the dark complexity of Sherlock Holmes. And alongside her own masterpieces, such as the novel *And Then There Were None*, published in 1939, Christie produced nearly unreadable clunkers, including 1927's *The Big Four*. But Christie's admirers point to her ability to individualize a dozen characters with a few economical descriptions and crisp lines of dialogue; her sense of humor, pacing and finely woven plots; and her productivity. "She told a rattling good story," says Curran. What's more, Christie's flair for drama and mystery extended to her own life, which was filled with subplots—and twists—worthy of her novels.

Agatha Mary Clarissa Miller was born on September 15, 1890, at Ashfield, her parents' villa on Barton Hill Road in a hillside neighborhood of Torquay. Her father, Frederick Miller, was the charmingly indolent scion of a wealthy New York family; because his stepmother was British, he grew up on both sides of the Atlantic. Miller spent his days playing whist at Torquay's Gentlemen's Club and taking part in amateur theatricals; her mother, Clara Boehmer, instilled in Agatha, the youngest of three children, a love of reading and an active

imagination. “I had a very happy childhood,” she wrote in her autobiography, which she began in 1950 and completed 15 years later. “I had a home and garden that I loved; a wise and patient Nanny; as father and mother two people who loved each other dearly and made a success of their marriage and of parenthood.” Christie’s idyll disintegrated in the late 1890s, however, when her father squandered his inheritance through a series of bad business deals. He died of pneumonia at age 55 when Agatha was 11. From that point, the family scraped by with a puny income that Clara received from the law firm of her late father-in-law.

Agatha grew into an attractive, self-confident young woman, the belle of Torquay’s social scene. She fended off a dozen suitors, including a young airman, Amyas Boston, who would return to Torquay 40 years later, as a top commander in the Royal Air Force. “He sent a note to Christie at Greenway requesting a meeting for old times’ sake,” says John Risdon, a Torquay historian and Christie expert. “And he got a reply back saying no thanks, she would rather have him ‘cherish the memory of me as a lovely girl at a moonlight picnic...on the last night of your leave.’” She had, says Risdon, “a thread of romanticism that went right through her life.” In 1912 she met Archie Christie, an officer in the Royal Flying Corps, at a Torquay dance. They married two years later, and Archie went off to France to fight in the Great War. During his absence, Agatha cared for injured soldiers at Torquay’s hospital, then—in a move that would prove fateful—she distributed medicinal compounds at a local dispensary. That work alerted her to the “fascination for poison,” wrote Laura Thompson in her recent biography, *Agatha Christie: An English Mystery*. “The beautiful look of the bottles, the exquisite precision of the calculations, the potential for mayhem contained within order” captivated the future crime writer.

By the time Christie tried her hand at a detective novel, in 1916, “I was well steeped in the Sherlock Holmes tradition,” she would recall in her autobiography. The story she devised, a whodunit set in motion by a strychnine poisoning, introduced some of her classic motifs: multiple suspects and murder among the British upper classes—as well as a Belgian refugee who helps Scotland Yard solve the case. Poirot “was hardly more than five feet four inches, but carried himself with great dignity,” Christie wrote in her promising debut, *The Mysterious Affair at Styles*. “His head was exactly the shape of an egg, and he always perched it a little on one side. His moustache was very stiff and military. The neatness of his attire was almost incredible; I believe a speck of dust would have caused him more pain than a bullet wound.” Four years later, by which time Christie was living in London with Archie and their infant daughter, Rosalind, the publishing firm Bodley Head accepted the manuscript. They offered a small royalty after the first 2,000 books were sold, and locked Christie in for an additional five novels under the same terms. “Bodley Head really ripped her off,” says Curran.

Then, in 1926, Christie experienced a series of life-changing turns. In June of that year, *The Murder of Roger Ackroyd*, her sixth novel, was published by William Collins to critical acclaim and far more generous remuneration. The book, notable for its surprising denouement—Poirot exonerates the original suspects and identifies his own assistant, the story’s narrator, as the murderer—“established Christie as a writer,” says Curran. That summer, Archie announced that he had fallen in love with his secretary and wanted a divorce. And on December 4, Agatha Christie’s Morris car was found abandoned at the edge of a lake near the village of Albury in Surrey, outside London, with no sign of its owner. Her disappearance set off a nationwide manhunt that riveted all of England. Police drained ponds, scoured underbrush and searched London buses. The tabloids floated rumors that Christie had committed suicide or that Archie had poisoned her. Eleven days after her disappearance, two members of a band performing at the Swan Hydropathic Hotel in Harrogate, Yorkshire, reported to police that a guest registered as “Mrs. Teresa Neele” from Cape Town, South Africa, resembled newspaper photographs of the missing writer. Tracked down by police and reunited briefly with Archie, Christie never explained why she had vanished. The never-solved mystery has, over the decades, prompted speculation that she was seeking to punish her husband for his desertion or had suffered a nervous breakdown. The episode also inspired a 1979 film, *Agatha*, starring Dustin Hoffman and Vanessa Redgrave, which imagined Christie heading to Harrogate to hatch a diabolical revenge plot.

In September 1930, Christie married Max Mallowan, an archaeologist she had met six months earlier on a visit to the ancient Babylonian city of Ur in today’s Iraq. The couple settled near Oxford, where she increased her literary output. In 1934, Christie produced two detective novels—*Murder on the Orient Express* and *Why Didn’t They Ask Evans?*—two short story collections, and a romance novel written under the Westmacott pseudonym. From 1935 on, British editions of her whodunits sold an average of 10,000 hardcovers—a remarkable figure for the time and place. Her popularity soared during World War II, when Blitz-weary

Britons found her tidy tales of crime and punishment a balm for their fears and anxieties. “When people got up in the morning, they didn’t know whether they’d go to bed at night, or even have a bed to go to,” says Curran. “Christie’s detective novels were very reassuring. By the end the villain was caught and order restored.” Grandson Prichard told me that Christie’s tales of crime and punishment demonstrate “her belief in the power of evil, and her belief in justice.”

One frigid December morning, I visited Prichard in his office at Agatha Christie Limited, in central London. He greeted me in a bright room filled with framed original covers and facsimile first editions of Christie’s novels, now published by HarperCollins. Since his mother’s death, Prichard, 67, has been principal guardian of his grandmother’s legacy, screening requests to adapt Christie’s work for media from film and computer games to graphic novels, overseeing merchandising agreements, and, on occasion, taking trespassers to court. In 1977, Agatha Christie Limited filed a lawsuit against the creators of *Agatha*, claiming that the film, then in production, took liberties with the story of her disappearance. The company lost its case, although Prichard believes that the lawsuit probably made the film “marginally less fictional than it might have been.” More recently, Prichard approved a revival of *A Daughter’s a Daughter*, a loosely autobiographical drama Christie wrote as Mary Westmacott. Prichard, who attended the December 2009 opening of the play, admitted its depiction of a troubled mother-daughter relationship mirrored that of Christie and her daughter, Rosalind. Writing in the *Daily Telegraph*, critic Charles Spencer characterized the work as “a fascinating, neglected curiosity.”

Prichard describes his childhood at Greenway during the 1950s as “the anchor of my growing up...I used to toddle down the stairs, and my grandmother would tell me early morning stories, and she followed my career when I was at [Eton], my cricket.” He settled back in his desk chair. “I was fortunate. I was the only grandchild, so all of her attention was concentrated on me.” After dinner, Prichard went on, Christie would retire to the drawing room and read aloud from corrected proofs of her latest novel to an intimate group of friends and family. (Intensely disciplined, she began writing a novel each January and finished by spring, sometimes working from a tent in the desert when she accompanied Mallowan on digs in the Middle East.) “My grandfather’s brother Cecil, archaeologists from Iraq, the chairman of Collins and [*Mousetrap* producer] Peter Saunders might be there,” Prichard recalled. “Eight or ten of us would be scattered round, and her reading the book took a week or ten days. We were a lot more relaxed back then.”

Prichard says he was taken aback by the 2009 research paper that suggested his grandmother suffered from dementia during the last years of her life. According to the *New York Times*, the researchers digitized 14 Christie novels and searched for “linguistic indicators of the cognitive deficits typical of Alzheimer’s Disease.” They found that Christie’s next-to-last novel, published in 1972, when she was 82, exhibited a “staggering drop in vocabulary” when compared with a novel she had written 18 years earlier—evidence, they postulated, of dementia. “I said to my wife, ‘If my grandmother had Alzheimer’s when she wrote those books, there were an awful lot of people who would have loved to have Alzheimer’s.’” (For his part, scholar John Curran believes that the quality of Christie’s novels *did* decline at the end. “Mathew and I have a disagreement about this,” he says.)

Today, Prichard enjoys occasional visits to Greenway, posing as a tourist. He was both pleased—and somewhat disconcerted—he says, by the first-year crush of visitors to his childhood summer home. Fortunately, more than half chose to arrive not by car, but by bicycle, on foot or by ferry down the River Dart; the effort to minimize vehicular traffic kept relations largely amicable between the National Trust and local residents. But there have been a few complaints. “Hopefully the fuss will die down a little, the numbers will go down rather than up, but one never knows. It’s difficult [for the local community],” he told me.

Back at Greenway, Robyn Brown and I wander through the sun-splashed breakfast room and cozy salon where Christie’s readings took place, and eye the bathtub where, Brown says, “Agatha liked to get in with a book and an apple.” In their last years, Rosalind and Anthony Hicks had been too ill to maintain the house properly; Brown points out evidence of renovations that shored up sagging walls, replaced rotting beams, repaired dangerous cracks—and revealed intriguing glimpses of the house’s history. Standing outside the winter dining room, she gestures to the floor. “We did some digging, and found a Victorian underfloor heating system here,” she tells me. “Underneath the flue we found cobbled pavement that was in front of the Tudor court. So in fact we are standing in front of the original Tudor house.” (That house, built around 1528, was demolished by Greenway’s late 18th-century owner, Roope Harris Roope, who constructed the Georgian mansion on the site.)

Stepping outside, we admire the house's graceful, butterscotch-yellow facade, with its two-columned central portico and single-story wings added in 1823. Beyond a curving gravel driveway, a steep drop-off descends to the Dart. I follow a forest path for several hundred yards to a slate-roofed, stone boathouse, one of Christie's favorite places, which sits above a sandy strip of river beach covered with clumps of black-green seaweed. In Christie's 1956 novel, *Dead Man's Folly*, Poirot joins a mystery writer, Ariadne Oliver, for a party at a Devon estate called Nasse House—a stand-in for Greenway—and there discovers the corpse of a young girl lying beside the secluded boathouse. The Battery is nearby—a stone plaza flanked by a pair of 18th-century cannons; it made a cameo appearance in *Five Little Pigs*.

Although the estate inspired scenes in several of her novels, Christie seldom, if ever, wrote at Greenway. It was, Brown emphasizes, an escape from the pressures of work and fame, a restorative retreat where she slipped easily into the roles of grandmother, wife and neighbor. "It's the place where she could be Mrs. Mallowan," Brown says. "She went to the village shop to get her hair cut, went to a fishmonger in Brixham, hired a bus and took local school kids to see *Mousetrap*. She was very much a part of the local community."

The opening of Greenway has shed some light on the author's private world. But, three and a half decades after her death, the source of Agatha Christie's genius—and many aspects of her life—remain a mystery worthy of Jane Marple or Hercule Poirot.

Writer **Joshua Hammer** lives in Berlin. Photographer Michael freeman is based in London.

Read more: http://www.smithsonianmag.com/travel/Where-Agatha-Christie-Dreamed-Up-Murder.html#ixzz1FGqnlaN3

How to Turn 8,000 Plastic Bottles Into a Building

Peace Corps volunteer Laura Kutner demonstrates how she turned trash into the building blocks for one community's revival

Peace Corps volunteer Laura Kutner rallied the community to stuff plastic bottles with trash. In all, the Guatemalan students turned 8,000 bottles into building materials.

- By Arcynta Ali Childs
- *Smithsonian* magazine, June 2011

Laura Kutner wants your trash—specifically, your plastic bottles. And, if you can spare some time, she'd like your help using those bottles to build a wall.

The construction project, which will commence at this summer's Smithsonian Folklife Festival (June 30-July 4 and July 7-11), is part of a celebration marking the 50th anniversary of the Peace Corps. Kutner, 26, will be giving visitors to the National Mall an opportunity to recreate a project she led in Granados, a poor community in the mountainous region of Baja Verapaz, Guatemala.

When Kutner arrived there as a volunteer in July 2007, the area was known for three things: its marble production, ample fields of corn and an abundance of garbage. "Community members were fantastic about reusing items," she says. But with a single dump nearby and few ways of getting trash to it, heavy buildup was a recurring problem.

Sitting outdoors with a group of students one day, Kutner was drinking from a soda bottle and...Eureka! "I realized that the plastic bottle I was holding was the exact width of the metal frame that was sitting outside the school," she says, referring to a previous building project that had run out of funds. Kutner had read about communities elsewhere in Latin America using plastic bottles stuffed with compacted trash as building material. Perhaps, Kutner thought, the rest of the schoolhouse wall could be contructed using the same technique, but with the addition of steel rods to provide extra reinforcement.

Local engineers gave the plan their stamp of approval. "The idea that we could create this structure out of the waste that is lying around on the ground and not need as many funds as we would with traditional blocks was very appealing," Kutner says. "Everyone in the community loved it." Then the work began.

Bottles measuring 600 milliliters (about 20 fluid ounces) had to be collected, cleaned and stored. Kutner and school principal Reyna Ortiz held workshops to explain what trash should stuff the bottles—no biodegradables, like paper and cardboard—just plastic and aluminum wrappers. Ortiz required each student to

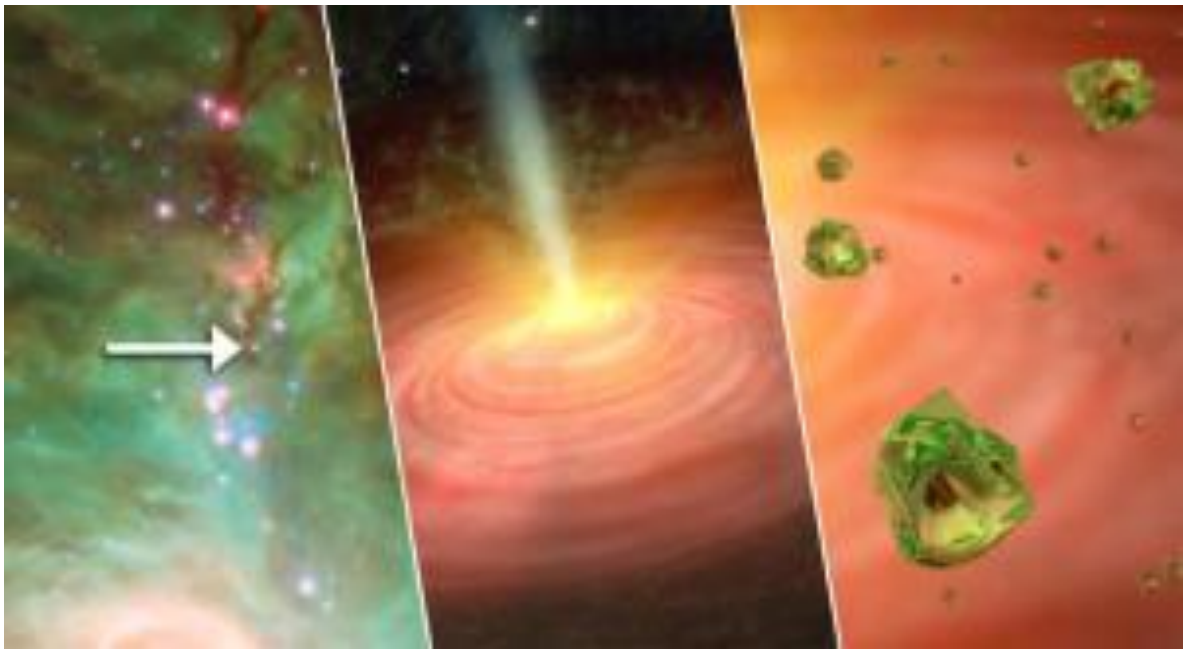
fill 20 bottles and awarded points for completion. When the students exhausted all the trash in Granados, they went to neighboring villages to gather more. In all, they filled some 8,000 bottles. And on Valentine's Day 2009, construction of the wall began.

The workers started by filling metal frames—each measuring ten square feet—with bottles encased between sheets of chicken wire. Then they fastened together the front and back sides of the wire and covered the outside with concrete. Though Kutner was reassigned to San Miguel Dueñas, a town four hours south, just as the project was nearly completed, she was able to travel back and forth to see it through to the end. And in October 2009, the wall was finished. Since then, ten more schools have been built in Guatemala using the plastic bottle technique.

Kutner, who now lives in Oregon and plans to begin a graduate program in international development in the fall, says the Peace Corps is one of the few organizations "that really gets development work right. They teach you that if development work is going to be sustainable, it has to come from the community."

Find this article at:
http://www.smithsonianmag.com/arts-culture/How-to-Turn-8000-Plastic-Bottles-Into-a-Building.html

Spitzer Sees Crystal 'Rain' in Outer Clouds of Infant Star



NASA's Spitzer Space Telescope detected tiny green crystals, called olivine, thought to be raining down on a developing star. (Credit: NASA/JPL-Caltech/University of Toledo)

ScienceDaily (May 27, 2011) — Tiny crystals of a green mineral called olivine are falling down like rain on a burgeoning star, according to observations from NASA's Spitzer Space Telescope.

This is the first time such crystals have been observed in the dusty clouds of gas that collapse around forming stars. Astronomers are still debating how the crystals got there, but the most likely culprits are jets of gas blasting away from the embryonic star.

"You need temperatures as hot as lava to make these crystals," said Tom Megeath of the University of Toledo in Ohio. He is the principal investigator of the research and the second author of a new study appearing in *Astrophysical Journal Letters*. "We propose that the crystals were cooked up near the surface of the forming star, then carried up into the surrounding cloud where temperatures are much colder, and ultimately fell down again like glitter."

Spitzer's infrared detectors spotted the crystal rain around a distant, sun-like embryonic star, or protostar, referred to as HOPS-68, in the constellation Orion.

The crystals are in the form of forsterite. They belong to the olivine family of silicate minerals and can be found everywhere from a periodot gemstone to the green sand beaches of Hawaii to remote galaxies. NASA's Stardust and Deep Impact missions both detected the crystals in their close-up studies of comets.

"If you could somehow transport yourself inside this protostar's collapsing gas cloud, it would be very dark," said Charles Poteet, lead author of the new study, also from the University of Toledo. "But the tiny crystals might catch whatever light is present, resulting in a green sparkle against a black, dusty backdrop."

Forsterite crystals were spotted before in the swirling, planet-forming disks that surround young stars. The discovery of the crystals in the outer collapsing cloud of a proto-star is surprising because of the cloud's colder temperatures, about minus 280 degrees Fahrenheit (minus 170 degrees Celsius). This led the team of astronomers to speculate the jets may in fact be transporting the cooked-up crystals to the chilly outer cloud.

The findings might also explain why comets, which form in the frigid outskirts of our solar system, contain the same type of crystals. Comets are born in regions where water is frozen, much colder than the searing temperatures needed to form the crystals, approximately 1,300 degrees Fahrenheit (700 degrees Celsius). The leading theory on how comets acquired the crystals is that materials in our young solar system mingled together in a planet-forming disk. In this scenario, materials that formed near the sun, such as the crystals, eventually migrated out to the outer, cooler regions of the solar system.

Poteet and his colleagues say this scenario could still be true but speculate that jets might have lifted crystals into the collapsing cloud of gas surrounding our early sun before raining onto the outer regions of our forming solar system. Eventually, the crystals would have been frozen into comets. The Herschel Space Observatory, a European Space Agency-led mission with important NASA contributions, also participated in the study by characterizing the forming star.

"Infrared telescopes such as Spitzer and now Herschel are providing an exciting picture of how all the ingredients of the cosmic stew that makes planetary systems are blended together," said Bill Danchi, senior astrophysicist and program scientist at NASA Headquarters in Washington.

The Spitzer observations were made before it used up its liquid coolant in May 2009 and began its warm mission.

NASA's Jet Propulsion Laboratory in Pasadena, Calif., manages the Spitzer Space Telescope mission for the agency's Science Mission Directorate in Washington. Science operations are conducted at the Spitzer Science Center at the California Institute of Technology in Pasadena. Caltech manages JPL for NASA.

For more information about Spitzer, visit http://www.nasa.gov/spitzer and http://spitzer.caltech.edu/ .

Story Source:

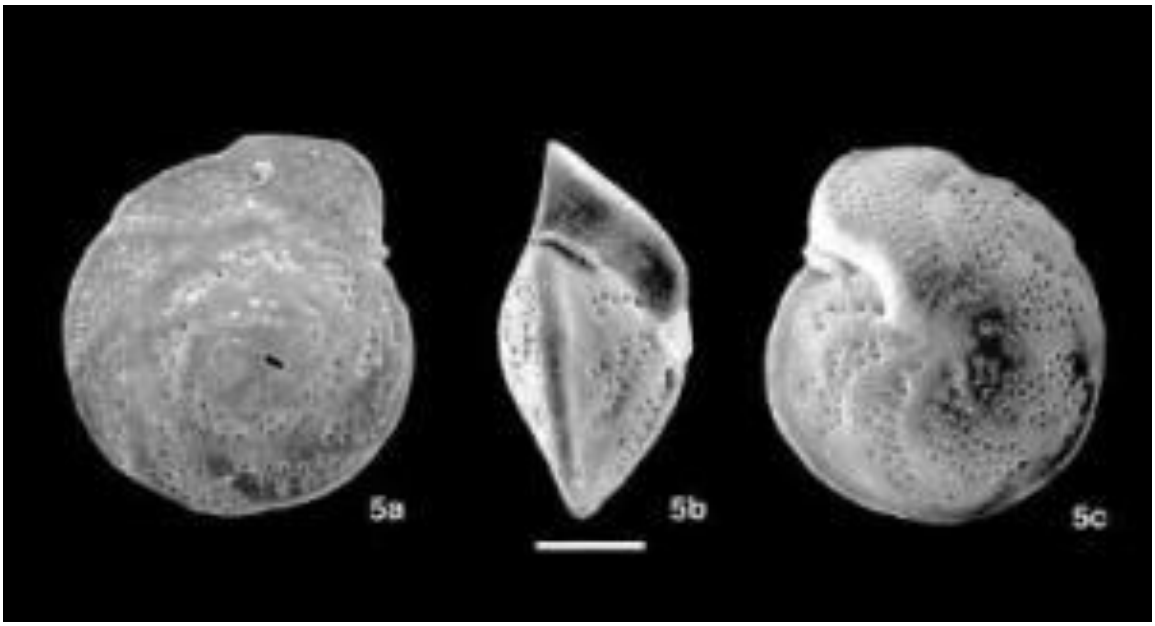
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **NASA/Jet Propulsion Laboratory**.

Journal Reference:

1. Charles A. Poteet, S. Thomas Megeath, Dan M. Watson, Nuria Calvet, Ian S. Remming, Melissa K. McClure, Benjamin A. Sargent, William J. Fischer, Elise Furlan, Lori E. Allen, Jon E. Bjorkman, Lee Hartmann, James Muzerolle, John J. Tobin, Babar Ali. **A Spitzer Infrared Spectrograph Detection of Crystalline Silicates in a Protostellar Envelope**. *The Astrophysical Journal*, 2011; 733 (2): L32 DOI: 10.1088/2041-8205/733/2/L32

http://www.sciencedaily.com/releases/2011/05/110526142957.htm

Significant Role Played by Oceans in Ancient Global Cooling



During their lifetime, foraminifera incorporate certain elements and elemental isotopes depending on environmental conditions. By analyzing the ratios of different isotopes and elements, the researchers are able to reconstruct the past environmental conditions that surrounded the foraminifera during their life. (Credit: Image courtesy of Rensselaer Polytechnic Institute)

ScienceDaily (May 28, 2011) — Thirty-eight million years ago, tropical jungles thrived in what are now the cornfields of the American Midwest and furry marsupials wandered temperate forests in what is now the frozen Antarctic. The temperature differences of that era, known as the late Eocene, between the equator and Antarctica were only half of what they are today. A debate has long been raging in the scientific community on what changes in our global climate system led to such a major shift from the more tropical, greenhouse climate of the Eocene to the modern and much cooler climates of today.

New research published in the journal *Science*, led by Rensselaer Polytechnic Institute scientist Miriam Katz, is providing some of the strongest evidence to date that the Antarctic Circumpolar Current (ACC) played a key role in the major shift in the global climate that began approximately 38 million years ago. The research provides the first evidence that early ACC formation played a vital role in the formation of the modern ocean structure.

The paper, titled "Impact of Antarctic Circumpolar Current development on late Paleogene ocean structure," is published in the May 27, 2011, issue of *Science*.

"What we have found is that the evolution of the Antarctic Circumpolar Current influenced global ocean circulation much earlier than previous studies have shown," said Katz, who is assistant professor of earth and environmental science at Rensselaer. "This finding is particularly significant because it places the impact of initial shallow ACC circulation in the same interval when the climate began its long-term shift to cooler temperatures."

There has been a debate over the past 40 years on what role the Antarctic Circumpolar Current had in the underlying cooling trend on Earth. Previous research has placed the development of the deep ACC (greater than 2,000 meters water depth) in the late Oligocene (approximately 23-25 million years ago). This is well after the global cooling pattern had been established. With this research, Katz and her colleagues used information from ocean sediments to place the global impact of the ACC to approximately 30 million years ago, when it was still just a shallow current.

Oceans and global temperatures are closely linked. Warmer ocean waters result in warmer air temperatures and vice versa. In the more tropical environs of the Eocene, ocean circulation was much weaker and currents were more diffuse. As a result, heat was more evenly distributed around the world. This resulted in fairly mild

oceans and temperatures worldwide, according to Katz. Today, ocean temperatures vary considerably and redistribute warm and cold water around the globe in significant ways.
"As the global ocean currents were formed and strengthened, the redistribution of heat likely played a significant role in the overall cooling of the Earth," Katz said.
And no current is more significant than the ACC. Often referred to as the "Mixmaster" of the ocean, the ACC thermally isolates Antarctica by preventing warm surface waters from subtropical gyres to pass through its current. The ACC instead redirects some of that warm surface water back up toward the North Atlantic, creating the Antarctic Intermediate Water. This blocking of heat enabled the formation and preservation of the Antarctic ice sheets, according to Katz. And it is this circumpolar circulation that Katz's research concludes was responsible for the development of our modern four-layer ocean current and heat distribution system.
To come to her conclusions, Katz looked at the uptake of different elemental isotopes in the skeletons of small organisms found in ocean sediments. The organisms, known as benthic foraminifera, are found in extremely long cores of sediments drilled from the bottom of the ocean floor.
During their lifetime, foraminifera incorporate certain elements and elemental isotopes depending on environmental conditions. By analyzing the ratios of different isotopes and elements, the researchers are able to reconstruct the past environmental conditions that surrounded the foraminifera during their life.
Specifically, they looked at isotopes of oxygen and carbon, along with ratios of magnesium versus calcium. More detailed information on Katz's isotopic analysis methods can be found at http://green.rpi.edu/archives/fossils/index.html.
Analysis of these isotopes from sediment cores extracted directly off the North American Atlantic coast showed the earliest evidence for the Antarctic Intermediate Waters, which circulates strictly as a direct consequence of the ACC. This finding is the first evidence of the effects of shallow ACC formation. The findings place development of the ACC's global impact much closer to the time that Antarctica separated from South America. It had previously been thought that the currents moving through this new continental gateway could not be strong enough at such shallow depths to affect global ocean circulation.
Katz points out that the larger cooling trend addressed in the paper has been punctuated by many short, but often significant, episodes of global warming. Such ancient episodes of warming are another significant aspect of her research program, and play an important role in understanding the modern warming of the climate occurring on the planet.
"By reconstructing the climates of the past, we can provide a science-based means to explore or predict possible system responses to the current climate change," Katz said.
Katz is joined in the research by Benjamin Cramer of Theiss Research; J.R. Toggweiler of Geophysical Fluid Dynamics Lab/NOAA; Chengjie Liu of ExxonMobil Exploration Co.; Bridget Wade of University of Leeds; and Gar Esmay, Kenneth Miller, Yair Rosenthal, and James Wright of Rutgers University.

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

Journal Reference:

1. M. E. Katz, B. S. Cramer, J. R. Toggweiler, G. Esmay, C. Liu, K. G. Miller, Y. Rosenthal, B. S. Wade, J. D. Wright. **Impact of Antarctic Circumpolar Current Development on Late Paleogene Ocean Structure**. *Science*, 2011; 332 (6033): 1076 DOI: 10.1126/science.1202122

http://www.sciencedaily.com/releases/2011/05/110526141406.htm

Chameleon Magnets: Ability to Switch Magnets 'On' or 'Off' Could Revolutionize Computing

Theoretical physicist Igor Zutic has been exploring ways to use magnets to revolutionize computing. (Credit: Image courtesy of University at Buffalo)

ScienceDaily (May 28, 2011) — What causes a magnet to be a magnet, and how can we control a magnet's behavior? These are the questions that University at Buffalo researcher Igor Zutic, a theoretical physicist, has been exploring over many years.

He is one of many scientists who believe that magnets could revolutionize computing, forming the basis of high-capacity and low-energy memory, data storage and data transfer devices.

In a recent commentary in *Science*, Zutic and fellow UB physicist John Cerne, who studies magnetism experimentally, discuss an exciting advancement: A study by Japanese scientists showing that it is possible to turn a material's magnetism on and off at room temperature.

A material's magnetism is determined by a property all electrons possess: something called "spin." Electrons can have an "up" or "down" spin, and a material is magnetic when most of its electrons possess the same spin. Individual spins are akin to tiny bar magnets, which have north and south poles.

In the Japanese study, which also appears in the current issue of *Science*, a team led by researchers at Tohoku University added cobalt to titanium dioxide, a nonmagnetic semiconductor, to create a new material that, like a chameleon, can transform from a paramagnet (a nonmagnetic material) to a ferromagnet (a magnetic material) at room temperature.

To achieve change, the researchers applied an electric voltage to the material, exposing the material to extra electrons. As Zutic and Cerne explain in their commentary, these additional electrons -- called "carriers" -- are mobile and convey information between fixed cobalt ions that causes the spins of the cobalt electrons to align in one direction.

In an interview, Zutic calls the ability to switch a magnet "on" or "off" revolutionary. He explains the promise of magnet- or spin-based computing technology -- called "spintronics" -- by contrasting it with conventional electronics.

Modern, electronic gadgets record and read data as a blueprint of ones and zeros that are represented, in circuits, by the presence or absence of electrons. Processing information requires moving electrons, which consumes energy and produces heat.

Spintronic gadgets, in contrast, store and process data by exploiting electrons' "up" and "down" spins, which can stand for the ones and zeros devices read. Future energy-saving improvements in data processing could include devices that process information by "flipping" spin instead of shuttling electrons around.

In their Science commentary, Zutic and Cerne write that chameleon magnets could "help us make more versatile transistors and bring us closer to the seamless integration of memory and logic by providing smart hardware that can be dynamically reprogrammed for optimal performance of a specific task."

"Large applied magnetic fields can enforce the spin alignment in semiconductor transistors," they write. "With chameleon magnets, such alignment would be tunable and would require no magnetic field and could revolutionize the role ferromagnets play in technology."

In an interview, Zutic says that applying an electric voltage to a semiconductor injected with cobalt or other magnetic impurities may be just one way of creating a chameleon magnet.

Applying heat or light to such a material could have a similar effect, freeing electrons that can then convey information about spin alignment between ions, he says.

The so-far elusive heat-based chameleon magnets were first proposed by Zutic in 2002. With his colleagues, Andre Petukhov of the South Dakota School of Mines and Technology, and Steven Erwin of the Naval Research Laboratory, he elucidated the behavior of such magnets in a 2007 paper.

The concept of nonmagnetic materials becoming magnetic as they heat up is counterintuitive, Zutic says. Scientists had long assumed that orderly, magnetic materials would lose their neat, spin alignments when heated -- just as orderly, crystalline ice melts into disorderly water as temperatures rise.

The carrier electrons, however, are the key. Because heating a material introduces additional carriers that can cause nearby electrons to adopt aligned spins, heating chameleon materials -- up to a certain temperature -- should actually cause them to become magnetic, Zutic explains. His research on magnetism is funded by the Department of Energy, Office of Naval Research, Air Force Office of Scientific Research and the National Science Foundation.

Story Source:

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

Journal Reference:

1. I. Zutic, J. Cerne. **Chameleon Magnets**. *Science*, 2011; 332 (6033): 1040 DOI: 10.1126/science.1205775

http://www.sciencedaily.com/releases/2011/05/110527162509.htm

Students Struggling With Math May Have a Neurocognitive Disorder Called Dyscalculia: Disorder Affects Roughly as Many People as Dyslexia

Students who struggle to learn mathematics may have a neurocognitive disorder that inhibits the acquisition of basic numerical and arithmetic concepts, according to a new article. Called developmental dyscalculia, the disorder affects roughly the same number of people as dyslexia but has received much less attention (and research funding). (Credit: © happyone / Fotolia)

ScienceDaily (May 28, 2011) — Students who struggle to learn mathematics may have a neurocognitive disorder that inhibits the acquisition of basic numerical and arithmetic concepts, according to a new paper. Specialised teaching for individuals with dyscalculia, the mathematical equivalent of dyslexia, should be made widely available in mainstream education, according to a review of current research published in the journal *Science*.

Although just as common as dyslexia, with an estimated prevalence of up to 7% of the population, dyscalculia has been neglected as a disorder of cognitive development. However, a world-wide effort by scientists and educators has established the essential neural network that supports arithmetic, and revealed abnormalities in this network in the brains of dyscalulic learners.

Neuroscience research shows what kind of help is most needed -- strengthening simple number concepts. This can be achieved with appropriate specially-designed teaching schemes, which can be supported by game-like software that adapts to the learner's current level of competence.

Professor Brian Butterworth, co-author of the paper and a member of the Centre for Educational Neuroscience (CEN) from the UCL Institute of Cognitive Neuroscience, said: "Dyscalculia is at least as much of a handicap for individuals as dyslexia and a very heavy burden on the state, with the estimated cost to the UK of low numeracy standing at £2.4 billion."

"Nevertheless, there are only cursory references to the disorder on the Department of Education website -- no indications are offered for help either for learners, teachers or parents. It's as if the government does not want to acknowledge its existence."

Like dyslexia, dyscalculia is a condition we are born with, and may be heritable in many or most cases. Research from twins and special populations suggests that an arithmetical disability has a large genetic component, but the genes responsible have not yet been located.

Professor Diana Laurillard, another co-author and a member of CEN from the Institute of Education (IOE), University of London, said: "Just because dyscalculia is inherited it does not mean that there is nothing that can be done about it. As with dyslexia, specialized teaching can help. At the IOE we have developed software resources specifically to help children with dyscalculia, based on brain research showing exactly what problems the brain is having."

One of the main challenges of the effort to understand dyscalculia, is for scientists from these very different disciplines to understand each others' methods and results. The creation of interdisciplinary and inter-institutional centres to promote joint work, such as the Centre for Educational Neuroscience established by UCL (University College London); the Institute of Education, University of London and Birkbeck University of London, aims to address this challenge.

Professor Laurillard added: "Results from neuroscience and developmental psychology tell us that dyscalculic learners need to practice far more number manipulation tasks than mainstream learners. Adaptive, game-like programs that focus on making numbers meaningful, emulating what skilled SEN teachers do, can help learners practice beyond the classroom and build the basic understanding they need to tackle arithmetic."

What is dyscalculia?

Examples of common indicators of dyscalculia are (i) carrying out simple number comparison and addition tasks by counting, often using fingers, well beyond the age when it is normal, and (ii) finding approximate estimation tasks difficult. Individuals identified as dyscalculic behave differently from their mainstream peers, for example:

- To say which is the larger of two playing cards showing 5 and 8, they count all the symbols on each card.
- To place a playing card of 8 in sequence between a 3 and a 9 they count up spaces between the two to identify where the 8 should be placed.
- To count down from 10 they count up from 1 to 10, then 1 to 9, etc.
- To count up from 70 in tens, they say '70, 80, 90, 100, 200, 300…'
- They estimate the height of a normal room as '200 feet?'

Story Source:

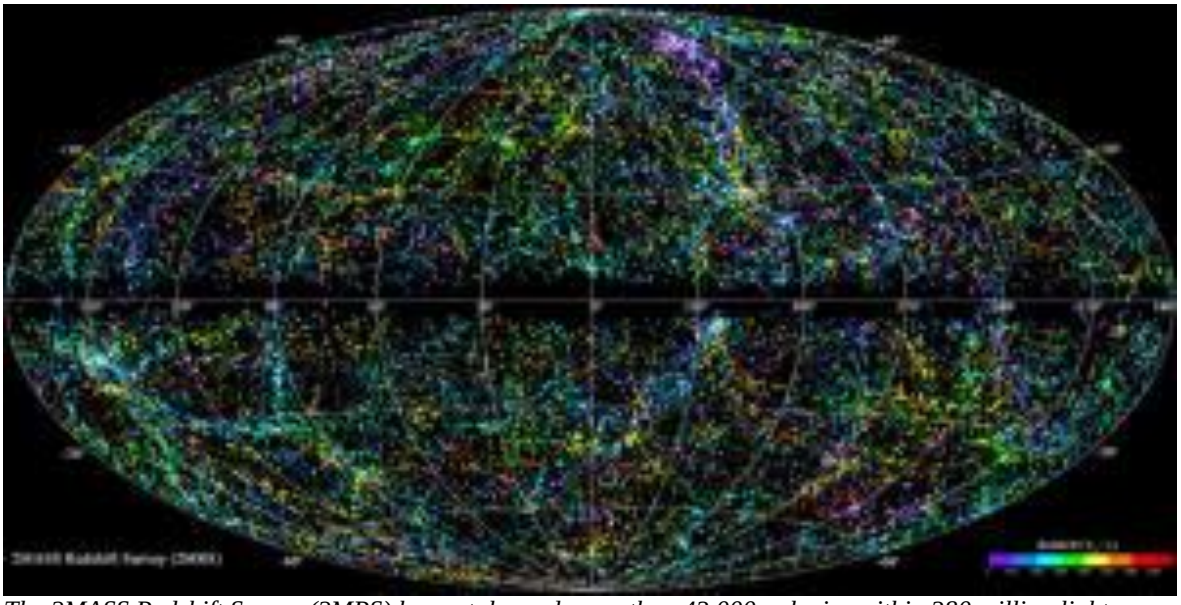
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University College London**, via EurekAlert!, a service of AAAS.

Journal Reference:

1. Brian Butterworth, Sashank Varma and Diana Laurillard. **Dyscalculia: From Brain to Education**. *Science*, 27 May 2011: Vol. 332 no. 6033 pp. 1049-1053 DOI: 10.1126/science.1201536

http://www.sciencedaily.com/releases/2011/05/110526141414.htm

Astronomers Unveil Most Complete 3-D Map of Local Universe



The 2MASS Redshift Survey (2MRS) has catalogued more than 43,000 galaxies within 380 million light-years from Earth (z<0.09). In this projection, the plane of the Milky Way runs horizontally across the center of the image. 2MRS is notable for extending closer to the Galactic plane than previous surveys - a region that's generally obscured by dust. (Credit: T.H. Jarrett (IPAC/SSC))

ScienceDaily (May 27, 2011) — Astronomers have unveiled the most complete 3-D map of the local universe (out to a distance of 380 million light-years) ever created. Taking more than 10 years to complete, the 2MASS Redshift Survey (2MRS) also is notable for extending closer to the Galactic plane than previous surveys -- a region that's generally obscured by dust.

Karen Masters (University of Portsmouth, UK) presented the new map May 25, 2011 in a press conference at the 218th meeting of the American Astronomical Society.

"The 2MASS Redshift Survey is a wonderfully complete new look at the local universe -- particularly near the Galactic plane," Masters said. "We're also honoring the legacy of the late John Huchra, an astronomer at the Harvard-Smithsonian Center for Astrophysics, who was a guiding force behind this and earlier galaxy redshift surveys."

A galaxy's light is redshifted, or stretched to longer wavelengths, by the expansion of the universe. The farther the galaxy, the greater its redshift, so redshift measurements yield galaxy distances -- the vital third dimension in a 3-D map.

2MRS chose galaxies to map from images made by the Two-Micron All-SkySurvey (2MASS). This survey scanned the entire sky in three near-infrared wavelength bands. Near-infrared light penetrates intervening dust better than visible light, allowing astronomers to see more of the sky. But without adding redshifts, 2MASS makes only a 2-D image. Some of the galaxies mapped had previously-measured redshifts, and Huchra started painstakingly measuring redshifts for the others in the late 1990s using mainly two telescopes: one at the Fred Lawrence Whipple Observatory on Mt. Hopkins, AZ, and one at the Cerro Tololo Inter-American Observatory in Chile. The last observations were completed by 2MRS observers on these telescopes shortly after Huchra's death in October 2010.

Robert Kirshner, Huchra's colleague at the Center for Astrophysics (CfA), said, "John loved doing redshift surveys and he loved the infrared. He had the insight to tell when infrared technology, formerly the province of the experts, was ripe for routine use in a big project."

"John was instrumental in setting up the 2MASS telescope at Mount Hopkins, seeing the infrared side of the project through, and making a much more complete survey of the local universe. It's a wonderful tribute to

John that his colleagues have finished the infrared-selected galaxy redshift survey that John started," he added.
The 2MRS mapped in detail areas previously hidden behind our Milky Way to better understand the impact they have on our motion. The motion of the Milky Way with respect to the rest of the universe has been a puzzle ever since astronomers were first able to measure it and found it couldn't be explained by the gravitational attraction from any visible matter. Massive local structures, like the Hydra-Centaurus region (the "Great Attractor") were previously hidden almost behind the Milky Way but are now shown in great detail by 2MRS.
Headquartered in Cambridge, Mass., the Harvard-Smithsonian Center for Astrophysics (CfA) is a joint collaboration between the Smithsonian Astrophysical Observatory and the Harvard College Observatory. CfA scientists, organized into six research divisions, study the origin, evolution and ultimate fate of the universe.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Harvard-Smithsonian Center For Astrophysics**.

http://www.sciencedaily.com/releases/2011/05/110527082038.htm

Drug May Help Overwrite Bad Memories

New research shows that recalling painful memories while under the influence of the drug metyrapone reduces the brain's ability to re-record the negative emotions associated with them. (Credit: © Mark Carrel / Fotolia)

ScienceDaily (May 27, 2011) — Recalling painful memories while under the influence of the drug metyrapone reduces the brain's ability to re-record the negative emotions associated with them, according to University of Montreal researchers at the Centre for Studies on Human Stress of Louis-H. Lafontaine Hospital. The team's study challenges the theory that memories cannot be modified once they are stored in the brain.

"Metyrapone is a drug that significantly decreases the levels of cortisol, a stress hormone that is involved in memory recall," explained lead author Marie-France Marin. Manipulating cortisol close to the time of forming new memories can decrease the negative emotions that may be associated with them. "The results show that when we decrease stress hormone levels at the time of recall of a negative event, we can impair the memory for this negative event with a long-lasting effect," said Dr. Sonia Lupien, who directed the research.

Thirty-three men participated in the study, which involved learning a story composed of neutral and negative events. Three days later, they were divided into three groups -- participants in the first group received a single dose of metyrapone, the second received double, while the third were given placebo. They were then asked to remember the story. Their memory performance was then evaluated again four days later, once the drug had cleared out.. "We found that the men in the group who received two doses of metyrapone were impaired when retrieving the negative events of the story, while they showed no impairment recalling the neutral parts of the story," Marin explained. "We were surprised that the decreased memory of negative information was still present once cortisol levels had returned to normal."

The research offers hope to people suffering from syndromes such as post-traumatic stress disorder. "Our findings may help people deal with traumatic events by offering them the opportunity to 'write-over' the emotional part of their memories during therapy," Marin said. One major hurdle, however, is the fact that metyrapone is no longer commercially produced. Nevertheless, the findings are very promising in terms of future clinical treatments. "Other drugs also decrease cortisol levels, and further studies with these compounds will enable us to gain a better understanding of the brain mechanisms involved in the modulation of negative memories."

The research is published in the *Journal of Clinical Endocrinology and Metabolism*.

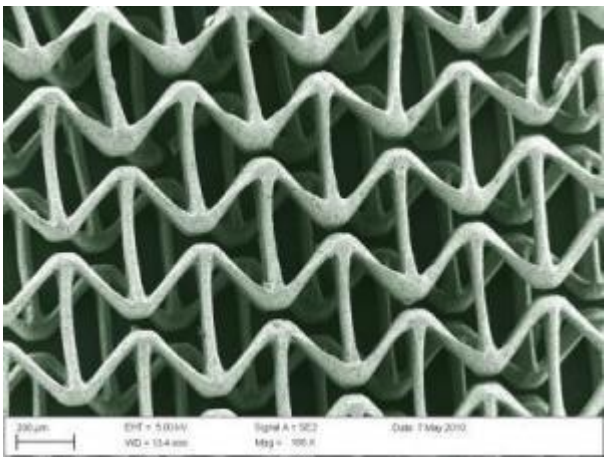
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of Montreal**, via EurekAlert!, a service of AAAS.

Journal Reference:

1. M.-F. Marin, A. Hupbach, F. S. Maheu, K. Nader, S. J. Lupien. **Metyrapone Administration Reduces the Strength of an Emotional Memory Trace in a Long-Lasting Manner**. *Journal of Clinical Endocrinology & Metabolism*, 2011; DOI: 10.1210/jc.2011-0226

http://www.sciencedaily.com/releases/2011/05/110526064802.htm

Nanoengineers Invent New Biomaterial That More Closely Mimics Human Tissue



A new biomaterial designed for repairing damaged human tissue doesn't wrinkle up when it is stretched. The invention from nanoengineers at the University of California, San Diego marks a significant breakthrough in tissue engineering because it more closely mimics the properties of native human tissue. Pictured: Optical images of polyethylene glycol scaffolds expanding in response to stretching.(Note: green tone added to image.) (Credit: UC San Diego / Shaochen Chen)

ScienceDaily (May 27, 2011) — A new biomaterial designed for repairing damaged human tissue doesn't wrinkle up when it is stretched. The invention from nanoengineers at the University of California, San Diego marks a significant breakthrough in tissue engineering because it more closely mimics the properties of native human tissue.

Shaochen Chen, professor in the Department of NanoEngineering at the UC San Diego Jacobs School of Engineering, hopes future tissue patches, which are used to repair damaged heart walls, blood vessels and skin, for example, will be more compatible with native human tissue than the patches available today. His findings were published in a recent issue of the journal *Advanced Functional Materials*.

The new biomaterial was created using a new biofabrication platform that Chen is developing under a four-year, $1.5 million grant from the National Institutes of Health. This biofabrication technique uses light, precisely controlled mirrors and a computer projection system -- shined on a solution of new cells and polymers -- to build three-dimensional scaffolds with well-defined patterns of any shape for tissue engineering.

"We are also exploring other opportunities," said Chen. "It's a new material. I think it's just a matter of time before more people will pick up and find applications for it in defense, energy and communications, for instance."

Although Chen's team is focused on creating biological materials, he said the manufacturing technology could be used to engineer many other kinds of materials including metal parts used in ships and spacecraft, for example.

Shape turned out to be essential to the new material's mechanical property. While most engineered tissue is layered in scaffolds that take the shape of circular or square holes, Chen's team created two new shapes called "reentrant honeycomb" and "cut missing rib." Both shapes exhibit the property of negative Poisson's ratio (i.e. not wrinkling when stretched) and maintain this property whether the tissue patch has one or multiple layers. One layer is double the thickness of a human hair, and the number of layers used in a tissue patch depends on the thickness of the native tissue that doctors are trying to repair. A single layer would not be thick enough to repair a heart wall or skin tissue, for example. The next phase of research will involve working with the Department of Bioengineering at the Jacobs School of Engineering to make tissue grafts to repair damaged blood vessels.

The team includes postdoctoral researchers in multiple disciplines: David Fozdar with the University of Texas at Austin, Department of Mechanical Engineering; Li-Hsin Han with the Stanford University School of

Medicine, Department of Orthopeadic Surgery; and Pranav Soman and Jim Woo Lee at the UCSD Jacobs School of Engineering Department of NanoEngineering.

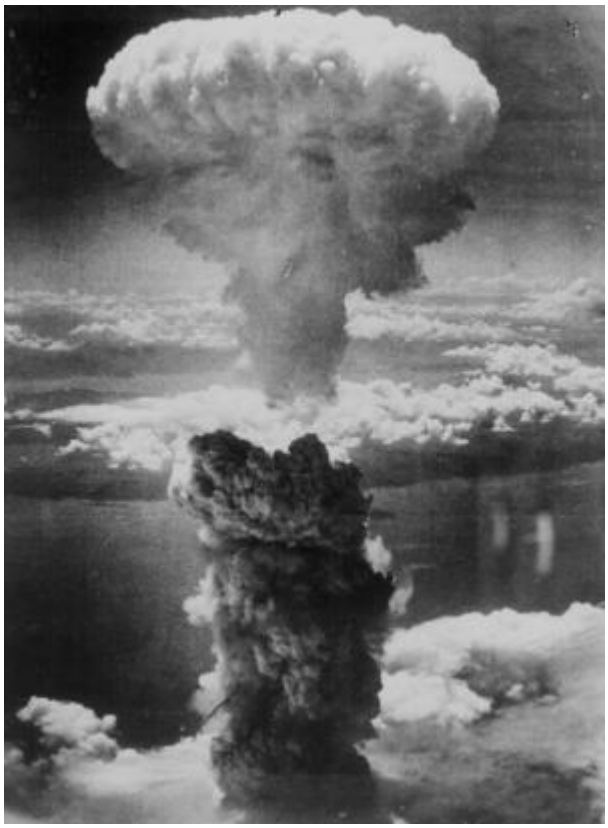
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of California - San Diego**.

Journal Reference:

1. David Y. Fozdar, Pranav Soman, Jin Woo Lee, Li-Hsin Han, Shaochen Chen. **Three-Dimensional Polymer Constructs Exhibiting a Tunable Negative Poisson's Ratio**. *Advanced Functional Materials*, 2011; DOI: 10.1002/adfm.201002022

http://www.sciencedaily.com/releases/2011/05/110526091806.htm

Nuclear Radiation Affects Sex of Babies, Study Suggests



A dense column of smoke rises more than 60,000 feet into the air over the Japanese port of Nagasaki, the result of an atomic bomb, the second ever used in warfare, dropped on the industrial center August 8, 1945, from a U.S. B-29 Superfortress. (Credit: U.S. National Archives and Records Administration)

ScienceDaily (May 27, 2011) — Ionizing radiation is not without danger to human populations. Indeed, exposure to nuclear radiation leads to an increase in male births relative to female births, according to a new study by Hagen Scherb and Kristina Voigt from the Helmholtz Zentrum München.

Their work shows that radiation from atomic bomb testing before the Partial Test Ban Treaty in 1963, the Chernobyl accident, and from living near nuclear facilities, has had a long-term negative effect on the ratio of male to female human births (sex odds). The research is published in the June issue of Springer's journal *Environmental Science and Pollution Research*.

Ionizing radiation from nuclear activity is known to have mutagenic properties and is therefore likely to have detrimental reproductive effects. It is thought that it may cause men to father more sons and mothers to give birth to more girls. Scherb and Voigt look at the long-term effects of radiation exposure on sex odds -- a unique genetic indicator that may reveal differences in seemingly normal as well as adverse pregnancy outcomes between maternal exposure and paternal exposure. In particular, they focus on sex odds data with respect to global atmospheric atomic bomb test fallout in Western Europe and the US, fallout due to nuclear accidents in the whole of Europe, and radioactive releases from nuclear facilities under normal operating conditions in Switzerland and Germany.

Their analyses show a significant male-female gap in all three cases:

- Increases in male births relative to female births in Europe and the US between 1964-1975 are a likely consequence of the globally emitted and dispersed atmospheric atomic bomb test fallout, prior to the test ban in 1963, that affected large human populations overall after a certain delay.

- There was a significant jump of sex odds in Europe in the year 1987 following Chernobyl, whereas no such similar effect was seen in the US, which was less exposed to the consequences of the catastrophe.
- Among populations living in the proximity of nuclear facilities (within 35km or 22 miles), the sex odds also increased significantly in both Germany and Switzerland during the running periods of those facilities.

Taken together these findings show a long-term, dose-dependent impact of radiation exposure on human sex odds, proving cause and effect. What is less clear is whether this increase in male births relative to female births is the result of a reduced frequency of female births or an increased number of male births. The authors estimate that the deficit of births and the number of stillborn or impaired children after the global releases of ionizing radiation amount to several millions globally.
Scherb and Voigt conclude: "Our results contribute to disproving the established and prevailing belief that radiation-induced hereditary effects have yet to be detected in human populations. We find strong evidence of an enhanced impairment of humankind's genetic pool by artificial ionizing radiation."

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Springer Science+Business Media**.

Journal Reference:

1. Hagen Scherb, Kristina Voigt. **The human sex odds at birth after the atmospheric atomic bomb tests, after Chernobyl, and in the vicinity of nuclear facilities**. *Environmental Science and Pollution Research*, 2011; 18 (5): 697 DOI: 10.1007/s11356-011-0462-z

http://www.sciencedaily.com/releases/2011/05/110526091308.htm

NASA's Hubble Finds Rare 'Blue Straggler' Stars in the Milky Way's Hub

Peering deep into the star-filled, ancient hub of our Milky Way (left), the Hubble Space Telescope has found a rare class of oddball stars called blue stragglers, the first time such objects have been detected within our galaxy's bulge. Blue stragglers -- so named because they seem to be lagging behind in their rate of aging compared with the population from which they formed -- were first found inside ancient globular star clusters half a century ago. This discovery is a spin-off from a seven-day-long survey conducted in 2006 called the Sagittarius Window Eclipsing Extrasolar Planet Search (SWEEPS). Hubble peered at and obtained variability information for 180,000 stars in the crowded central bulge of our galaxy, 26,000 light-years away. The picture at right shows the 42 blue straggler candidates circled in green. (Credit: NASA, ESA, W. Clarkson (Indiana University and UCLA), and K. Sahu (STScI))

ScienceDaily (May 27, 2011) — NASA's Hubble Space Telescope has found a rare class of oddball stars called blue stragglers in the hub of our Milky Way, the first detected within our galaxy's bulge.

Blue stragglers are so named because they seemingly lag behind in the aging process, appearing younger than the population from which they formed. While they have been detected in many distant star clusters, and among nearby stars, they never have been seen inside the core of our galaxy.

It is not clear how blue stragglers form. A common theory is that they emerge from binary pairs. As the more massive star evolves and expands, the smaller star gains material from its companion. This stirs up hydrogen fuel and causes the growing star to undergo nuclear fusion at a faster rate. It burns hotter and bluer, like a massive, young star.

The findings support the idea that the Milky Way's central bulge stopped making stars billions of years ago. It now is home to aging sun-like stars and cooler red dwarfs. Giant blue stars that once lived there have long since exploded as supernovae.

The results have been accepted for publication in an upcoming issue of the *Astrophysical Journal*. Lead author Will Clarkson of Indiana University in Bloomington and the University of California in Los Angeles, will discuss them May 25, 2011 at the American Astronomical Society meeting in Boston.

"Although the Milky Way bulge is by far the closest galaxy bulge, several key aspects of its formation and subsequent evolution remain poorly understood," Clarkson said. "Many details of its star-formation history remain controversial. The extent of the blue straggler population detected provides two new constraints for models of the star-formation history of the bulge."

The discovery followed a seven-day survey in 2006 called the Sagittarius Window Eclipsing Extrasolar Planet Search (SWEEPS). Hubble peered at 180,000 stars in the crowded central bulge of our galaxy, 26,000 light-years away. The survey was intended to find hot Jupiter-class planets that orbit very close to their stars. In doing so, the SWEEPS team also uncovered 42 oddball blue stars with brightness and temperatures typical for stars much younger than ordinary bulge stars.

The observations clearly indicate that if there is a young star population in the bulge, it is very small. It was not detected in the SWEEPS program. Blue stragglers long have been suspected to be living in the bulge, but had not been observed because younger stars in the disk of our galaxy lie along the line-of-sight to the core, confusing and contaminating the view.

Astronomers used Hubble to distinguish the motion of the core population from foreground stars in the Milky Way. Bulge stars orbit the galactic center at a different speed than foreground stars. Plotting their motion required returning to the SWEEPS target region with Hubble two years after the first observations were made. The blue stragglers were identified as moving along with the other stars in the bulge.
"The size of the field of view on the sky is roughly that of the thickness of a human fingernail held at arm's length, and within this region, Hubble sees about a quarter million stars toward the bulge," Clarkson said. "Only the superb image quality and stability of Hubble allowed us to make this measurement in such a crowded field."
From the 42 candidate blue stragglers, the investigators estimate 18 to 37 are likely genuine. The remainder could be a mix of foreground objects and, at most, a small population of genuinely young bulge stars.
"The SWEEPS program was designed to detect transiting planets through small light variations," said Kailash Sahu, the principal investigator of the SWEEPS program. "Therefore the program could easily detect the variability of binary pairs, which was crucial in confirming these are indeed blue stragglers."
Hubble is a project of international cooperation between NASA and the European Space Agency. NASA's Goddard Space Flight Center in Greenbelt, Md., manages the telescope. The Space Telescope Science Institute (STScI) conducts Hubble science operations. STScI is operated for NASA by the Association of Universities for Research in Astronomy in Washington. For images and more information about the findings, visit: http://www.nasa.gov/hubble and http://hubblesite.org/news/2011/16

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

http://www.sciencedaily.com/releases/2011/05/110525144301.htm

Autism Changes Molecular Structure of the Brain: Discovery Points to a Common Cause for Multifaceted Disease

For decades, autism researchers have faced a baffling riddle: how to unravel a disorder that leaves no known physical trace as it develops in the brain. Now a UCLA study is the first to reveal how the disorder makes its mark at the molecular level, resulting in an autistic brain that differs dramatically in structure from a healthy one. (Credit: © Tramper2 / Fotolia)

ScienceDaily (May 27, 2011) — For decades, autism researchers have faced a baffling riddle: how to unravel a disorder that leaves no known physical trace as it develops in the brain.

Now a UCLA study is the first to reveal how the disorder makes its mark at the molecular level, resulting in an autistic brain that differs dramatically in structure from a healthy one. Published May 25 in the advance online edition of *Nature*, the findings provide new insight into how genes and proteins go awry in autism to alter the mind.

The discovery also identifies a new line of attack for researchers, who currently face a vast array of potential fronts for tackling the neurological disease and identifying its diverse causes.

"If you randomly pick 20 people with autism, the cause of each person's disease will be unique," said principal investigator Dr. Daniel Geschwind, the Gordon and Virginia MacDonald Distinguished Chair in Human Genetics and a professor of neurology and psychiatry at the David Geffen School of Medicine at UCLA. "Yet when we examined how genes and proteins interact in autistic people's brains, we saw well-defined shared patterns. This common thread could hold the key to pinpointing the disorder's origins."

The research team, led by Geschwind, included scientists from the University of Toronto and King's College London. They compared brain tissue samples obtained after death from 19 autism patients and 17 healthy volunteers. After profiling three brain areas previously linked to autism, the group zeroed in on the cerebral cortex, the most evolved part of the human brain.

The researchers focused on gene expression -- how a gene's DNA sequence is copied into RNA, which directs the synthesis of cellular molecules called proteins. Each protein is assigned a specific task by the gene to perform in the cell.

By measuring gene-expression levels in the cerebral cortex, the team uncovered consistent differences in how genes in autistic and healthy brains encode information.
"We were surprised to see similar gene expression patterns in most of the autistic brains we studied," said first author Irina Voineagu, a UCLA postdoctoral fellow in neurology. "From a molecular perspective, half of these brains shared a common genetic signature. Given autism's numerous causes, this was an unexpected and exciting finding."
The researchers' next step was to identify the common patterns. To do this, they looked at the cerebral cortex's frontal lobe, which plays a role in judgment, creativity, emotions and speech, and at its temporal lobes, which regulate hearing, language and the processing and interpreting of sounds.
When the scientists compared the frontal and temporal lobes in the healthy brains, they saw that more than 500 genes were expressed at different levels in the two regions.
In the autistic brains, these differences were virtually non-existent.
"In a healthy brain, hundreds of genes behave differently from region to region, and the frontal and temporal lobes are easy to tell apart," Geschwind said. "We didn't see this in the autistic brain. Instead, the frontal lobe closely resembles the temporal lobe. Most of the features that normally distinguish the two regions had disappeared."
Two other clear-cut patterns emerged when the scientists compared the autistic and healthy brains. First, the autistic brain showed a drop in the levels of genes responsible for neuron function and communication. Second, the autistic brain displayed a jump in the levels of genes involved in immune function and inflammatory response.
"Several of the genes that cropped up in these shared patterns were previously linked to autism," said Geschwind. "By demonstrating that this pathology is passed from the genes to the RNA to the cellular proteins, we provide evidence that the common molecular changes in neuron function and communication are a cause, not an effect, of the disease."
The next step will be for the research team to expand its search for the genetic and related causes of autism to other regions of the brain.
Autism is a complex brain disorder that strikes in early childhood. The disease disrupts a child's ability to communicate and develop social relationships and is often accompanied by acute behavioral challenges. In the United States, autism spectrum disorders are diagnosed in one in 110 children -- and one in 70 boys. Diagnoses have expanded tenfold in the last decade.
The study was funded by the National Institute of Mental Health, the Canadian Institutes of Health Research, and Genome Canada. Tissue samples were provided by the Autism Tissue Project, the Harvard Brain Bank and the Medical Research Council's London Brain Bank for Neurodegenerative Disease.
Geschwind's and Voineagu's co-authors included Jennifer Lowe, Yuan Tian, Steve Horvath, Jonathan Mill and Rita Cantor of UCLA; Benjamin Blencowe and Xinchen Wang of the University of Toronto; and Patrick Johnston of King's College London.

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

Journal Reference:

1. Irina Voineagu, Xinchen Wang, Patrick Johnston, Jennifer K. Lowe, Yuan Tian, Steve Horvath, Jonathan Mill, Rita M. Cantor, Benjamin J. Blencowe, Daniel H. Geschwind. **Transcriptomic analysis of autistic brain reveals convergent molecular pathology**. *Nature*, 2011; DOI: 10.1038/nature10110

http://www.sciencedaily.com/releases/2011/05/110525131701.htm

Genetic Basis for Key Parasite Function in Malaria

ScienceDaily (May 27, 2011) — Snug inside a human red blood cell, the malaria parasite hides from the immune system and fuels its growth by digesting hemoglobin, the cell's main protein. The parasite, however, must obtain additional nutrients from the bloodstream via tiny pores in the cell membrane. Now, investigators from the National Institute of Allergy and Infectious Diseases (NIAID), part of the National Institutes of Health, have found the genes that malaria parasites use to create these feeding pores.

The research was led by Sanjay A. Desai, M.D., Ph.D., of NIAID's Laboratory of Malaria and Vector Research. In 2000, Dr. Desai co-discovered the primary type of feeding pore on parasite-infected blood cells, an ion channel known as the plasmodial surface anion channel (PSAC). Ion channels are pore-forming proteins that allow the movement of calcium, sodium and other particles into or out of the cell. A report of the team's new findings, which build on this original discovery, is now online in *Cell*.

"Despite recent progress in controlling malaria worldwide, the disease continues to kill more than 700,000 people, primarily young children, every year," said NIAID Director Anthony S. Fauci, M.D. "Dr. Desai and his colleagues have discovered the genetic basis of a fundamental aspect of malaria parasite biology, and in doing so, they have opened up potential new approaches to developing antimalarial drugs."

Scientists have known for decades that malaria-infected red blood cells have greater nutrient uptake than non-infected cells, presumably to support parasite survival and growth, noted Dr. Desai. But, he added, "It was debated whether the parasite co-opts existing human channels or uses its own proteins to remodel the red blood cell membrane."

To answer this question, the NIAID team screened nearly 50,000 chemicals for their ability to block nutrient uptake by cells infected with either of two genetically distinct lines of Plasmodium falciparum malaria parasites, HB3 and Dd2. Most chemicals were equally active against the two lines, but one, ISPA-28, stood out because it was 800 times more active against the nutrient channels of Dd2-infected red blood cells than against those of HB3-infected cells.

If the PSAC protein is made by the parasite, the scientists reasoned, the strikingly different effects of ISPA-28 on the two lines may reflect genetic differences. To explore this possibility, the investigators measured how well ISPA-28 inhibited PSAC activity in daughter parasites resulting from a genetic cross between the HB3 and Dd2 lines. They found that most daughter parasites made channels that were identical to those of one or the other parent, indicating that parasite genes play an important role. The inheritance pattern of ISPA-28 action on channels led the researchers to chromosome 3, where they found two parasite genes, clag3.1 and clag3.2, that appear to encode the PSAC protein.

This genetic evidence was bolstered when they showed that individual parasites express either the clag3.1 gene or the clag3.2 gene, but not both simultaneously. They found that switching between the two genes produced changes in PSAC behavior that could be predicted. Malaria parasites use gene switching as a way to protect essential proteins from attack by the immune system, Dr. Desai explained.

"We were surprised to discover a role for clag genes in PSAC activity," said Dr. Desai. This family of genes, which do not look like other ion channel genes, was previously thought to be involved in helping infected cells adhere to the inner lining of blood vessels. Clag genes are found in all species of malaria parasites, noted Dr. Desai, and this fact, along with the discovery that the parasites can choose between one of two channel genes to ensure nutrient uptake, strongly suggest that PSAC is required for parasite survival within red blood cells.

The discovery of parasite genes required for PSAC activity opens up several new research directions, said Dr. Desai. For example, development of antimalarial drugs that target these channels could be accelerated. The NIAID team has already found PSAC inhibitors that kill malaria parasites. Dr. Desai's team also is exploring how the PSAC protein is transported from the parasite to the red blood cell membrane, as preventing this transport may be another way to kill malaria parasites.

In addition to funding from NIAID's Division of Intramural Research, this study was supported by Medicines for Malaria Venture, a not-for-profit public-private partnership headquartered in Switzerland.

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **NIH/National Institute of Allergy and Infectious Diseases**, via EurekAlert!, a service of AAAS.

Journal Reference:

1. Wang Nguitragool, Abdullah A.B. Bokhari, Ajay D. Pillai, Kempaiah Rayavara, Paresh Sharma, Brad Turpin, L. Aravind, Sanjay A. Desai. **Malaria Parasite clag3 Genes Determine Channel-Mediated Nutrient Uptake by Infected Red Blood Cells**. *Cell*, Volume 145, Issue 5, 665-677, 27 May 2011 DOI: 10.1016/j.cell.2011.05.002

http://www.sciencedaily.com/releases/2011/05/110526122903.htm

Biomedical Imaging: Ultrasound Guide Star and Time-Reversal Mirror Can Focus Light Deep Under the Skin

ScienceDaily (May 26, 2011) — Astronomers have a neat trick they sometimes use to compensate for the turbulence of the atmosphere that blurs images made by ground-based telescopes. They create an artificial star called a guide star and use its twinkling to compensate for the atmospheric turbulence.
Lihong Wang, PhD, the Gene K. Beare Distinguished Professor of Biomedical Engineering at Washington University in St. Louis, has invented a guide star for biomedical rather than celestial imaging, a breakthrough that promises game-changing improvements in biomedical imaging and light therapy.
Wang's guide star is an ultrasound beam that "tags" light that passes through it. When it emerges from the tissue, the tagged light, together with a reference beam, creates a hologram.
When a "reading beam" is then shown back through the hologram, it acts as a time-reversal mirror, creating light waves that follow their own paths backward through the tissue, coming to a focus at their virtual source, the spot where the ultrasound is focused.
The technique, called time-reversed ultrasonically encoded (TRUE) optical focusing, thus allows the scientist to focus light to a controllable position within tissue.
Wang thinks TRUE will lead to more effective light imaging, sensing, manipulation and therapy, all of which could be a boon for medical research, diagnostics and therapeutics.
In photothermal therapy, for example, scientists have had trouble delivering enough photons to a tumor to heat and kill the cells. So they either have to treat the tumor for a long time or use very strong light to get enough photons to the site, Wang says. But TRUE will allow them to focus light right on the tumor, ideally without losing a single tagged photon to scattering.
"Focusing light into a scattering medium such as tissue has been a dream for years and years, since the beginning of biomedical optics," Wang says. "We couldn't focus beyond say a millimeter, the width of a hair, and now you can focus wherever you wish without any invasive measure."
The new method was published in *Nature Photonics*, which appeared online Jan. 16, and has since been spotlighted by *Physics Today* (both online and in print) and in a *Nature Photonics* Backstage Interview.

The problem

Light is in many ways the ideal form of electromagnetic radiation for imaging and treating biological tissues, but it suffers from an overwhelming drawback. Light photons ricochets off nonuniformities in tissue like a steel ball ricochets off the bumpers of an old-fashioned pinball machine.
This scattering prevents you from seeing even a short distance through tissue; you can't, for example, see the bones in your hand. Light of the right color can penetrate several centimeters into biological tissue, but even with the best current technology, it isn't possible to produce high-resolution images of objects more than a millimeter below the skin with light alone.
Ultrasound's advantages and drawbacks are in many ways complementary to those of light. Ultrasound scattering is a thousand times weaker than optical scattering.
Ultrasound reveals a tissue's density and compressibility, which are often not very revealing. For example, the density of early-stage tumors doesn't differ that much from that of healthy tissue.

Ultrasound tagging

The TRUE technique overcomes these problems by combining for the first time two tricks of biomedical imaging science: ultrasound tagging and time reversal.
Wang had experimented with ultrasound tagging of light in 1994 when he was working at the M.D. Anderson Cancer Center in Houston, Texas. In experiments using a tissue phantom (a model that mimics the opacity of tissue), he focused ultrasound into the phantom from above, and then probed the phantom with a laser beam from the side.
The laser light had only one frequency as it entered the tissue sample, but the ultrasound, which is a pressure wave, changed the tissue's density and the positions of its scattering centers. Light passing through the precise point where the ultrasound was focused acquired different frequency components, a change that "tagged" these photons for further manipulation.
By tuning a detector to these frequencies, it is possible to sort photons arriving from one spot (the ultrasound focus) within the tissue and to discard others that have bypassed the ultrasonic beam and carry no information about that spot. The tagged photons can then be used to paint an image of the tissue at the ultrasound focus.

Ultrasound modulation of light allowed Wang to make clearer images of objects in tissue phantoms than could be made with light alone. But this technology selects only photons that have traversed the ultrasound field and cannot focus light.

Time reversal

While Wang was working on ultrasound modulation of optical light, a lab at the Langevin Institute in Paris led by Mathias Fink, was working on time reversal of sound waves.

No law of physics is violated if waves run backward instead of forward. So for every burst of sound (or light) that diverges from a source, there is in theory a set of waves that could precisely retrace the path of the sound back to the source.

To make this happen, however, you need a time-reversal mirror, a device to send the waves backward along exactly the same path by which they arrived. In Fink's experiments, the mirror consisted of a line of transducers that detected arriving sound and fed the signal to a computer.

Each transducer then played back its sound in reverse -- in synchrony with the other transducers. This created what is called the conjugate of the original wave, a copy of the wave that traveled backward rather than forward and refocused on the original point source.

The idea of time reversal is so remote from everyday experience it is difficult to grasp, but as *Scientific American* reported at the time, if you stood in front of Fink's time-reversal "mirror" and said "hello," you would hear "olleh," and even more bizarrely, the sound of the "olleh," instead of spreading throughout the room from the loudspeakers, would converge onto your mouth.

In a 1994 experiment, Fink and his colleagues sent sound through a set of 2000 steel rods immersed in a tank of water. The sound scattered along all the possible paths through the rods, arriving at the transducer array as a chaotic wave. These signals were time-reversed and sent back through the forest of rods, refocusing to a point at the source location.

In effect, time reversal is a way to undo scattering.

Combining the tricks

Wang was aware of the work with time reversal, but at first couldn't see how it might help solve his problem with tissue scattering.

In 2004, Michael Feld, a physicist interested in biomedical imaging, invited Wang to give a seminar at the Massachusetts Institute of Technology. "At dinner we talked about time reversal," Wang says. "Feld was thinking about time reversal, I was thinking about time reversal, and so was another colleague dining with us."

"The trouble was, we couldn't figure out how to use it. You know, if you send light through a piece of tissue, the light will scatter all over the place, and if you capture it and reverse it, sending it back, it will still be scattered all over the place, so it won't concentrate photonsl."

"And then 13 years after the initial ultrasound-tagging experiments, I suddenly realized I could combine these two techniques.

"If you added ultrasound, then you could focus light into tissue instead of through tissue. Ultrasound tagging lets you reverse and send back only those photons you know are going to converge to a focus in the tissue."

"Ultrasound provides a virtual guide star, and to make optical time reversal effective, you need a guide star," Wang says.

A time-reversal mirror for light

It's much easier to make a time-reversal mirror for ultrasound than for light. Because sound travels slowly, it is easy to record the entire time course of a sound signal and then broadcast that signal in reverse order.

But a light wave arrives so fast it isn't possible to record a time course with sufficient time resolution. No detector will respond fast enough. The solution is to record an interference pattern instead of a time course.

The beam that has gone through the tissue and a reference beam form an interference pattern, which is recorded as a hologram by a special photorefractive crystal.

Then the wavefront is reconstructed by sending a reading beam through the crystal from the direction opposite to that of the reference beam. The reading beam reconstitutes a reversed copy of the original wavefront, one that comes to a focus at the ultrasound focus.

Unlike the usual hologram, the TRUE hologram is dynamic and constantly changing. Thus it is able to compensate for natural motions, such as breathing and the flow of blood, and it adapts instantly when the experimenter moves the ultrasonic focus to a new spot.

More photons to work with

Wang expects the TRUE technique for focusing light within tissue will have many applications, including optical imaging, sensing, manipulation and therapy. He also mentions its likely impact on the emerging field of optogenetics.

In optogenetics, light is used to probe and control living neurons that are expressing light-activatable molecules or structures. Optogenetics may allow the neural circuits of living animals to be probed at the high speeds needed to understand brain information processing.

But until now, optogenetics has suffered from the same limitation that plagues optical methods for studying biological tissues. Areas of the brain near the surface can be stimulated with light sources directly mounted on the skull, but to study deeper areas, optical fibers must be inserted into the brain.

TRUE will allow light to be focused on these deeper areas without invasive procedures, finally achieving the goal of making tissue transparent at optical frequencies.

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Washington University in St. Louis**. The original article was written by Diana Lutz.

Journal Reference:

1. Mathias Fink. **Imaging: Sharper focus by random scattering**. *Nature Photonics*, 2010; 4 (5): 269 DOI: 10.1038/nphoton.2010.95

http://www.sciencedaily.com/releases/2011/02/110211114327.htm

Testing Material Hardness and Strength: Butter Up the Old 'Scratch Test' to Make It Tough

Researchers used butter as a material for testing the fracture properties of materials. (Credit: Pedro Reis)

ScienceDaily (May 26, 2011) — It might not seem like scraping the top of a cold stick of butter with a knife could be a scientific test, but engineers at MIT say the process is very similar to the "scratch test," which is perhaps the oldest known way to assess a material's hardness and strength -- or, in scientific language, its resistance to deformation.

Using the scraping of butter as a starting point, the engineers launched a study to see if the age-old scratch test could be used to determine a material's toughness, or how well it resists fracturing after a small crack has already formed. The answer: The scratch test is indeed measuring crack resistance rather than strength and is valid on material samples of any size. This means that engineers now have a simple "new" test for assessing a material's fracture properties.

"Fracture mechanics has not reached the same level of pervasiveness in most engineering practice as strength theories, and this is due to the fact that it is difficult to determine fracture properties of materials, from soft clay to hard concrete," says Franz-Josef Ulm, the George Macomber Professor of Civil and Environmental Engineering (CEE) at MIT. "The test which we propose here is just this: a straightforward test for the engineering practice."

In a paper in *Physical Review Letters* that appeared online May 20, co-authors Ulm; Pedro Reis, the Esther and Harold E. Edgerton Assistant Professor of Civil and Environmental Engineering and Mechanical Engineering; and CEE graduate student Ange-Therese Akono -- who is first author on the paper -- describe their research and findings.

They performed laboratory scratch tests on paraffin wax, which is similar to butter but more stable at room temperature, Reis says, and used theory and mathematics to pare the process down to its essential components. They then created a mathematical model of the entire physical "scratch" process, which shows that the area of contact between the scratching implement and the test material is of primary importance in determining whether the scratch test is assessing strength or toughness.

They knew that when measuring a material's strength, the force required to make a scratch would always increase at the same rate as the contact area (width times depth) of the scratching tool.

But when measuring a material's toughness, the mechanics are complicated by the energy released when chemical bonds break as the new surfaces are created and a fracture grows. Because of this, the force does not increase at the same rate as the area of contact. Instead, the force exhibits a distinct scaling reminiscent of a fracture process -- that is, a wider cut requires more force than a deeper one. (Specifically, the force increases at the same rate as the width times the square root of the depth.)

Back in the lab, the engineers changed the dimensions of the test to see if a wider scratching implement would require more force than a narrow one. It did. And that seemingly minor change in one dimension gave them their answer: The scratch test is assessing a material's fracture toughness, not its hardness nor strength properties. It assesses the hardness and strength only in cases where the area of contact between the scratching implement and the material is so small that a true indentation is made rather than a scratch. Now, knowing the width and depth of the scratch and the horizontal force, researchers can now determine the fracture toughness of a material.

"The advantage of a scratch test is that it works on both soft and hard materials and on very small samples," Akono says. "This method enables us to isolate brittle-crack propagation and neglect plastic deformation." They confirmed their findings with additional tests on cement paste, limestone and steel.

"You might think that fracture, or how things break, is an old field of study," Reis says. "But it's relatively new compared to the tests of a material's hardness. Now, using the very old method of the scratch test, we have a relatively simple new means for measuring a material's toughness."

"The scalability of scratching for different probes and depths will open new venues for the miniaturization of the technique, which will help us understand fracture properties of materials at very small scales," Ulm says. "We also know -- finally -- that it takes less effort to make a narrow, deep cut in cold butter than a wide one. And that is science we can use at the dinner table."

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Massachusetts Institute of Technology, Department of Civil and Environmental Engineering**.

Journal Reference:

1. A-T. Akono, P. Reis, F-J. Ulm. **Scratching as a Fracture Process: From Butter to Steel**. *Physical Review Letters*, 2011; 106 (20) DOI: 10.1103/PhysRevLett.106.204302

http://www.sciencedaily.com/releases/2011/05/110526152551.htm

Cystic Fibrosis-Associated Bacteria Could Help Fight Back Against Antibiotic Resistance

ScienceDaily (May 28, 2011) — A bacteria which infects people with cystic fibrosis could help combat other antibiotic-resistant microbes, according to a team from Cardiff and Warwick Universities. Continuous use of existing antibiotics means that resistant bacteria are now causing major health problems all over the world. New antibiotics are urgently needed to combat the emergence of multidrug-resistant bacteria such as the MRSA superbug.

Now a surprising source of hope has emerged in the form of Burkholderia, a group of bacteria which can cause severe lung infections in people with the genetic disorder cystic fibrosis. However, the Cardiff and Warwick team has now discovered antibiotics from Burkholderia are effective against MRSA and even other cystic fibrosis infecting bacteria.

Dr Eshwar Mahenthiralingam, of Cardiff University's School of Biosciences, Cardiff University, has been studying Burkholderia for the last decade. Using forensic fingerprinting tests to genetically identify the bacteria, Dr Mahenthiralingam's research group has tracked strains all over the world and helped develop guidelines to prevent it spreading.

By the summer of 2007, Dr Mahenthiralingam had built up a large collection of Burkholderia bacteria. He and his team then decided to screen them for antibiotics active against other bacteria, particularly drugs with the potential to kill other bacteria that infect cystic fibrosis patients. Over the next two years, Dr Mahenthiralingam's team discovered that around one quarter of Burkholderia bacteria have very strong antibiotic activity on multidrug-resistant pathogens such as MRSA. One particular strain, Burkholderia ambifaria, was found to produce two very potent antibiotics active on resistant bacteria, in particular Acinetobacter baumanii.

The chemical structures of the antibiotics, called enacyloxins, were determined by Professor Gregory Challis and Dr. Lijiang Song at the University of Warwick, demonstrating that they belong to one of the most successful families of natural product drugs, the polyketides. Other examples of polyketides include erythromycin, which is used to cure many bacterial infections, and doxorubin, used as an anti-cancer drug.

Professor Challis commented: "The combination of enzymes used by Burkholderia to make the enacyloxins is very unusual. Our insights into this process should allow us to use cutting edge synthetic biology techniques to produce novel enacyloxin analogues with improved pharmaceutical properties."

The team's findings have now been published in the journal *Chemistry and Biology*. Dr Mahenthiralingam commented: "Burkholderia are soil bacteria like Streptomyces, which are the source of most of our current antibiotics. Our research therefore offers real hope of a completely new source for the identification and engineering of highly potent antibiotics. With antibiotic resistant bacteria causing great suffering around the world, these new sources are urgently needed."

Story Source:

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

Journal Reference:

1. Eshwar Mahenthiralingamsend email, Lijiang Song, Andrea Sass, Judith White, Ceri Wilmot, Angela Marchbank, Othman Boaisha, James Paine, David Knight, Gregory L. Challis. **Enacyloxins Are Products of an Unusual Hybrid Modular Polyketide Synthase Encoded by a Cryptic Burkholderia ambifaria Genomic Island**. *Chemistry & Biology*, Volume 18, Issue 5, 665-677, 27 May 2011 DOI: 10.1016/j.chembiol.2011.01.020

http://www.sciencedaily.com/releases/2011/05/110527101233.htm

Patients With Rheumatoid Arthritis Receive Less Protection from Pandemic Influenza With H1N1 Vaccine, Study Shows

ScienceDaily (May 28, 2011) — Individuals with rheumatoid arthritis taking disease modifying anti-rheumatic drugs, showed significantly less protection from pandemic influenza after receiving the H1N1 vaccine compared to healthy individuals, according to data presented at the EULAR 2011 Annual Congress. A Brazilian hospital-based study assessed responses to flu vaccines in 340 RA patients in regular follow-up compared to 234 healthy patients. Measures of protection obtained by vaccination (seroprotection rate (SP)) after immunization was over 20% lower for RA patients compared to healthy individuals (60.1% vs. 82.9% comparatively ($p<0.001$)). Tests to determine levels of detectable antibodies to microorganisms in the blood serum as a result of infection and immunization with the flu virus (seroconversion rate (SC)) showed a similar pattern with 53.4% of RA patients and 76.9% of healthy controls having antibodies present respectively ($p<0.001$).

"This study has highlighted that there are differences in the level of protection between the H1N1 vaccine and the seasonal influenza vaccine so healthcare professionals should not assume that immune response will be the same with different vaccines" said Professor A. Ribeiro of the University of Sao Paolo. "In planning for future pandemic outbreaks, healthcare professionals should consider specific immunization strategies to ensure this large population of patients are as fully protected as possible from the risk of contracting pandemic flu."

The vaccination's impact on disease activity (DAS28*) was also measured and nine patients (2.6%) reported worsening of symptoms with the mean disease activity score changing from 3.66 to 5.15 ($p<0.05$) after the H1N1 vaccination. No serious adverse events were seen across either patient group, although more subjects in the RA patient group reported more adverse events, 42% versus 30.8% with a rate of 140 events/100 patients versus 87/100 control group ($p<0.005$).

* DAS28 (Disease Activity Score) is an index used by physicians to measure how active an individual's RA is. It assesses number of tender and swollen joints (out of a total of 28), the ethroycyte sedimentation rate (ESR, a blood marker of inflammation), and the patient's 'global assessment of global health'. A higher score indicates more active disease.

Story Source:

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

http://www.sciencedaily.com/releases/2011/05/110526064635.htm

Physicists Explain the Long, Useful Lifetime of Carbon-14

Iowa State University physicists, left to right, Pieter Maris and James Vary have used supercomputing power to solve the puzzle of the long, slow decay of carbon-14. That long half-life makes carbon-14 a useful tool to determine the ages of skeletons and other artifacts. (Credit: Photo by Bob Elbert.)

ScienceDaily (May 28, 2011) — The long, slow decay of carbon-14 allows archaeologists to accurately date the relics of history back to 60,000 years.

And while the carbon dating technique is well known and understood (the ratio of carbon-14 to other carbon isotopes is measured to determine the age of objects containing the remnants of any living thing), the reason for carbon-14's slow decay has not been understood. Why, exactly, does carbon-14 have a half-life of nearly 6,000 years while other light atomic nuclei have half-lives of minutes or seconds? (Half-life is the time it takes for the nuclei in a sample to decay to half the original amount.)

"This has been a very significant puzzle to nuclear physicists for several decades," said James Vary, an Iowa State University professor of physics and astronomy. "And the underlying reason turned out to be a fairly exotic one."

The reason involves the strong three-nucleon forces (a nucleon is either a neutron or a proton) within each carbon-14 nucleus. It's all about the simultaneous interactions among any three nucleons and the resulting influence on the decay of carbon-14. And it's no easy task to simulate those interactions.

In this case, it took about 30 million processor-hours on the Jaguar supercomputer at Oak Ridge National Laboratory in Tennessee. Jaguar has a peak performance of 2.3 quadrillion calculations per second, a speed that topped the list of the world's top 500 supercomputers when the carbon-14 simulations were run.

The research project's findings were recently published online by the journal *Physical Review Letters.*

Vary and Pieter Maris, an Iowa State research staff scientist in physics and astronomy, are the lead authors of the paper. Collaborating on the paper are Petr Navratil of TRIUMF (Canada's National Laboratory for Particle and Nuclear Physics in Vancouver) and the Lawrence Livermore National Laboratory in California; Erich Ormand of Lawrence Livermore National Lab; plus Hai Ah Nam and David Dean of Oak Ridge National Lab. The research was supported by contracts and grants from the U.S. Department of Energy Office of Science.

Vary, in explaining the findings, likes to remind people that two subatomic particles with different charges will attract each other. Particles with the same charges repel each other. Well, what happens when there are three particles interacting that's different from the simple addition of their interactions as pairs?

The strong three-nucleon interactions are complicated, but it turns out a lot happens to extend the decay of carbon 14 atoms.

"The whole story doesn't come together until you include the three-particle forces," said Vary. "The elusive three-nucleon forces contribute in a major way to this fact of life that carbon-14 lives so long."
Maris said the three-particle forces work together to cancel the effects of the pairwise forces governing the decay of carbon-14. As a result, the carbon-14 half-life is extended by many orders of magnitude. And that's why carbon-14 is a very useful tool for determining the age of objects.
To get that answer, Maris said researchers needed a billion-by-billion matrix and a computer capable of handling its 30 trillion non-zero elements. They also needed to develop a computer code capable of simulating the entire carbon-14 nucleus, including the roles of the three-nucleon forces. Furthermore, they needed to perform the corresponding simulations for nitrogen-14, the daughter nucleus of the carbon-14 decay. And, they needed to figure out how the computer code could be scaled up for use on the Jaguar petascale supercomputer.
"It was six months of work pressed into three months of time," Maris said.
But it was enough for the nuclear physicists to explain the long half-life of carbon-14. And now they say there are more puzzles to solve:
"Everybody now knows about these three-nucleon forces," Vary said. "But what about four-nucleon forces? This does open the door for more study."

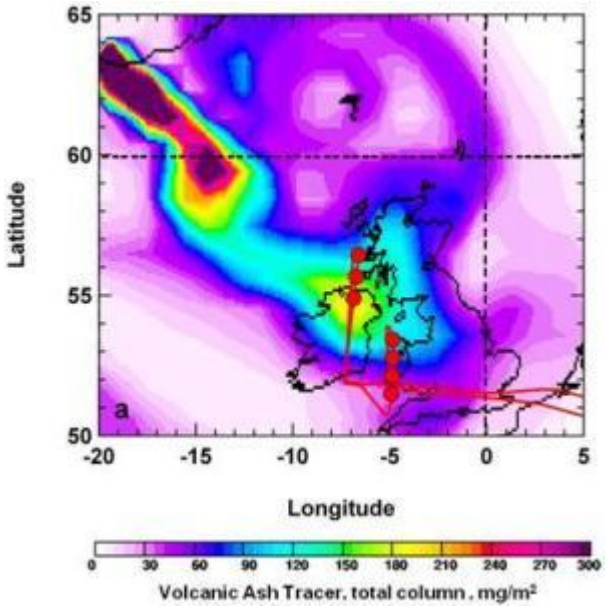
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Iowa State University**.

Journal Reference:

1. P. Maris, J. Vary, P. Navrátil, W. Ormand, H. Nam, D. Dean. **Origin of the Anomalous Long Lifetime of ^{14}C**. *Physical Review Letters*, 2011; 106 (20) DOI: 10.1103/PhysRevLett.106.202502

http://www.sciencedaily.com/releases/2011/05/110526122913.htm

Bleach in the Icelandic Volcanic Cloud



CARIBIC flight track from Frankfurt to the British Isles on May 16. The dots indicate air sampling locations. The colored regions depict the extent of the volcanic ash cloud as calculated using meteorological models, with red/yellow indicating high and purple low amounts of particles. (Credit: Figure taken from Baker et al., 2011 (GRL).)

ScienceDaily (May 27, 2011) — One year after the Eyjafjallajökull volcano in Iceland brought European air traffic to a standstill its ash plume revealed a surprising scientific finding: Researchers at the Max Planck Institute for Chemistry in Mainz found that the ash plume contained not only the common volcanic gas sulfur dioxide, but also free chlorine radicals. Chlorine radicals are extremely reactive and even small amounts can have a profound impact on local atmospheric chemistry. The findings, which will be published in "Geophysical Research Letters" give solid evidence of volcanic plume chlorine radical chemistry and allowed calculations of chlorine radical concentrations.

It has been known for some time that volcanic eruptions emit chlorine-containing gases, causing scientists to suspect that highly reactive chlorine radicals could also be present. However, sufficient experimental evidence proved elusive. That changed when researchers analyzed air collected in the ash cloud emitted by the Eyjafjallajökull volcano. During three special flights conducted by Lufthansa in spring 2010 using the CARIBIC atmospheric measurement container, researchers collected air samples which they brought back to their laboratory in Mainz for analysis. Among the compounds they looked for were hydrocarbons.

"Each volcano has its own character," says Angela Baker, lead author of the paper. "We found that hydrocarbon concentrations were up to 70% lower inside the Eyjafjallajökull ash cloud than outside. Reaction with chlorine radicals was the only realistic explanation for the hydrocarbon losses. And further investigation confirmed that free chlorine radicals were the cause." The scientists calculated concentrations of up to 66,000 chlorine atoms per cubic centimeter of air. While modest compared to concentrations of other gases, chlorine radicals are normally absent, and it does not take much of these very reactive atoms to have a noticeable impact on atmospheric chemistry.

Hydrocarbons like propane and butane can be found even in the cleanest and most remote parts of the lower atmosphere. Normally they are removed when they react with hydroxyl radicals, but they react many times faster with chlorine radicals. In doing so the chlorine reactions leave their specific "signature" on the mixture of hydrocarbons in the air. This signature can, in turn, be used to calculate how many chlorine radicals were present. The Max Planck scientists who calculated volcanic ash cloud chlorine radical concentrations for the first time anticipate that similar results will be found in plumes from other volcanoes, such as the currently erupting Grimsvötn. They also hope that their method will be used during future studies to identify and understand volcanic chlorine radical chemistry.

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

Journal Reference:

1. Angela K. Baker, Armin Rauthe-Schöch, Tanja J. Schuck, Carl A. M. Brenninkmeijer, Peter F. J. van Velthoven, Adam Wisher, David E. Oram. **Investigation of chlorine radical chemistry in the Eyjafjallajökull volcanic plume using observed depletions in non-methane hydrocarbons**. *Geophysical Research Letters*, 2011 DOI: 10.1029/2011GL047571

http://www.sciencedaily.com/releases/2011/05/110527080327.htm

New Procedure to Make Brain Surgery Safer

This is the Fraunhofer MEVIS neuro exhibit. (Credit: © Fraunhofer MEVIS)

ScienceDaily (May 27, 2011) — To increase patient safety in clinical practice and minimize risks and damage that may arise during surgery, computer support and digital medical imaging are key technologies. Before brain operations, neurosurgeons can now evaluate patient-specific surgical risks, achieve increased safety, and avoid unacceptable risks.

Brain interventions must be planned so that the neurosurgeon can access and remove the tumor without causing unnecessary damage. Before the brain tumor can be removed, crucial questions must be answered. Where do the functional areas of the cortex (gray matter) of the patient lie? What are the paths of the nerve fiber tracts that connect them? Answering these questions is important because the functional areas of the brain are interconnected via nerve pathways, also known as nerve fiber tracts. These nerve tracts must be protected as much as possible; otherwise, permanent dysfunction could occur. Furthermore, nerve tracts can be pushed or infiltrated by the brain tumor itself. If nerve tracts become damaged during an operation, there is a risk that distant functional areas connected to the tumor-afflicted part of the brain could be affected and induce lasting sensory, motor, and cognitive impairment. Therefore, neurosurgeons attempt to answer these questions for each patient during the planning stage of the brain operation to minimize the risks present in the intervention. To do so, surgeons require medical imagery of each patient's brain anatomy and function that is as realistic and precise as possible. However, medical images contain inaccuracies that arise from the processing, modeling, and reconstruction of patient data.

Solving these problems requires more than merely improving existing imaging methods. Mathematical analysis and models must be integrated to produce information about the location of the tumor, functional areas, and nerve fiber tracts, to increase the accuracy of patient-specific data, and to give the surgeon dependable knowledge.

The Fraunhofer MEVIS Institute for Medical Image Computing in Bremen, Germany has pioneered a procedure that analyzes uncertainty in patient-specific images, modeling, and reconstruction and incorporates this information into reconstructions of patient data. This procedure allows safety margins around nerve tracts in the brain to be more accurately determined. In addition, the reliability of the reconstructed data is

calculated to supply the surgeon with accurate information concerning nerve tract locations, paths, and intersections and to construct safety margins around the nerve fiber tracts. By integrating errors in measurement, reconstruction, and modeling, the exact locations of tracts in a space-occupying tumor are calculated. This gives the neurosurgeon a reliable prognosis concerning where the incision in the brain should be made and which safety margins should be chosen to avoid harming nerve tracts and irreversibly damaging important functional areas. Before an intervention, the surgeon can evaluate patient-specific risks. These software assistants will be refined and implemented for neuronavigation in future operations, providing the surgeon with updated information during surgery that can be compared to planning data.
The paths of nerve tracts in the brain and the functional areas that they connect can now be explored by visitors of the "New Paths in Medicine" exhibit on the MS Wissenschaft exhibition ship. The converted inland vessel is underway until September 29, 2011 and docks in 35 different cities. During the "Year of Health Research," visitors can familiarize themselves with the field's newest trends, developments, and research findings. The exhibit showcases a physical three-dimensional model of the brain produced through an innovative printing process based on the medical image data of a real person. This brain model can be touched and viewed from different angles thanks to its rotating base. Nerve tracts can be activated by touching sensors on the physical model that correspond to functional areas of the brain. The brain is displayed on a screen along with the activated nerve tracts that are responsible, for instance, for sight, speech, feeling, and motion. This new form of interactive exhibit was developed by Fraunhofer MEVIS in Bremen together with the Universum® Science Center in Bremen to demonstrate how modern image processing combined with mathematics and intelligent software can help make neurosurgical operations more predictable and safe. The three-dimensional print of the brain was produced by the Fraunhofer-Institut ITWM in Kaiserslautern.

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

http://www.sciencedaily.com/releases/2011/05/110527100134.htm

Green and Lean: Secreting Bacteria Eliminate Cost Barriers for Renewable Biofuel Production

Cyanobacteria. (Credit: Photo Courtesy of KDHE)

ScienceDaily (May 27, 2011) — A Biodesign Institute at Arizona State University research team has developed a process that removes a key obstacle to producing low-cost, renewable biofuels from bacteria. The team has reprogrammed photosynthetic microbes to secrete high-energy fats, making byproduct recovery and conversion to biofuels easier and potentially more commercially viable.

"The real costs involved in any biofuel production are harvesting the goodies and turning them into fuel," said Roy Curtiss, of the Institute's Center for Infectious Diseases and Vaccinology and professor in the School of Life Sciences. "This whole system that we have developed is a means to a green recovery of materials not requiring energy dependent physical or chemical processes."

Curtiss is part of a large, multidisciplinary ASU team that has been focusing on optimizing photosynthetic microbes, called cyanobacteria, as a renewable source of biofuels. These microbes are easy to genetically manipulate and have a potentially higher yield than any plant crops currently being used for the production of transportation fuels.

But, until now, harvesting the fats from the microbes has required many costly additional processing steps that contribute up to 70 to 80 percent of the total cost of their renewable biofuel production, making them uncompetitive compared with petroleum production costs.

Cyanobacteria have a tough, protective set of outer membranes that help the bacteria thrive in even harsh surroundings, creating the pond scum often found in backyard swimming pools. Like plants, they are dependent upon sunlight, water and carbon dioxide for growth.

To get cyanobacteria to more readily release their precious, high fat cargo, Curtiss and postdoctoral researcher Xinyao Liu, placed a suite of genes into photosynthetic bacteria that produced enzymes to degrade membrane lipids, poking holes in the membranes to release free fatty acids into the water. In a clever feat of genetic reprogramming of the cells, the enzymes are only produced when carbon dioxide -- a vital ingredient of bacterial growth -- is removed from their environment.

"We first freed up fatty acids by triggering self-destruction of the bacteria by adding nickel," Liu said, "but this is not so good for the environment. So, this time we did it in a smarter way -- by stopping carbon dioxide supply. The strategy of adding nothing for recovering fuels from biomass is designed to drastically reduce processing costs."

"Genetics is a very powerful tool," added Liu, who recently presented the results at the 3rd Annual World Algae Summit in San Diego, California. "We have created a very flexible system that we can finely control. After teaching cyanobacteria to excrete fuels, we don't want to waste the useful lipids in the photosynthetic membranes, so we developed a greener way to recycle the remaining value of the biofactory."

The team tested fat-degrading enzymes, called lipases, from bacterial, fungal and guinea pig sources to see which would work best. These lipases are able work like molecular scissors, clipping off the fatty acids from the photosynthetic membranes. They also worked to optimize the growth conditions of their green recovery method, testing variables such as the cell culture density of the microbes, light intensity and agitation of the cultures.

The team's ingenuity rests in part with their ability to utilize the full repertoire of nature's toolkit. "Due to rapid DNA sequencing and public gene databases, we can now use this vast and ever-increasing store of gene sequences with powerful computer search methods to identify the best genes and proteins with optimal functions and capabilities independent of their origin in microbes, plants and animals," said Curtiss. "It is like being a kid in a candy store the size of the State of Arizona and finding the most delicious candy treat almost in the time to snap your fingers!"

The project is also a prime example of the multidisciplinary, collaborative spirit of ASU research combining the expertise of bacteriologists, molecular biologists and engineers. Other key contributors were Biodesign colleagues Sarah Fallon and Jie Sheng.

Next, the group will test their results in large-scale photobioreactors, which are being designed by engineers in the institute's Swette Center for Environmental Biotechnology to optimally capture the free fatty acids. Ultimately, the team hopes to achieve development of a new, economical and environmentally friendly, carbon neutral source of biofuels.

"We are optimistic that we can make the system even better, leading to the commercialization of our green recovery method bundled with other technologies," said Liu.

The project has been part of the state of Arizona's strategic research investments to spur new innovation that may help foster future green and local industries. The state's abundant year-round sunshine and warm temperatures are ideally suited for growing cyanobacteria.

The work was supported by Biodesign Institute seed funding and a $5 million grant from the U.S. Department of Energy Advanced Research Projects Agency.

Story Source:

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

Journal Reference:

1. X. Liu, S. Fallon, J. Sheng, R. Curtiss. **CO2-limitation-inducible Green Recovery of fatty acids from cyanobacterial biomass**. *Proceedings of the National Academy of Sciences*, 2011; 108 (17): 6905 DOI: 10.1073/pnas.1103016108

http://www.sciencedaily.com/releases/2011/05/110526141511.htm

Secret Lives of Feral and Free-Roaming House Cats Tracked

The cats were fitted with radio collars and tracked over two years. Some of the collars also had devices that continuously monitored the cats' every move. This un-owned cat was one of those tracked. (Credit: Photo courtesy Illinois Natural History Survey)

ScienceDaily (May 27, 2011) — Researchers (and some cat-owners) wanted to know: What do feral and free-roaming house cats do when they're out of sight? A two-year study offers a first look at the daily lives of these feline paupers and princes, whose territories overlap on the urban, suburban, rural and agricultural edges of many towns.

Jeff Horn, a former graduate student in the department of natural resources and environmental sciences, and colleagues collaborated on a two-year study of owned and un-owned cats outdoors. Photo by Diana Yates

The study used radio telemetry and a sophisticated activity-tracking device to capture the haunts and habits of dozens of owned and un-owned cats living at the southern edge of Champaign and Urbana, neighboring cities in Central Illinois. Together, the 42 adult cats originally radio-tracked for the study ranged over a territory of 2,544 hectares (6,286 acres).

Of the radio transmitters used in the study, 23 had tilt and vibration sensors that tracked the animals' every move.

"There's no (other) data set like this for cats," said Jeff Horn, a former graduate student in the University of Illinois department of natural resources and environmental sciences who conducted the study for his master's thesis with researchers from his department and the Prairie Research Institute at Illinois. "Without these sensors, it would require a field team of 10 to 12 people to collect that data."

As expected, in most cases the un-owned cats had larger territories than the pet cats and were more active throughout the year. But the size of some of the feral cats' home ranges surprised even the researchers.
One of the feral cats, a mixed breed male, had a home range of 547 hectares (1,351 acres), the largest range of those tracked.
Like most of the feral cats, this lone ranger was seen in both urban and rural sites, from residential and campus lawns to agricultural fields, forests and a restored prairie.
One of the feral cats in the study, a mixed breed male, had a home range of 547 hectares (1,351 acres), the largest range of those tracked (red outline). A pet cat in the study, by contrast, stayed very close to home (yellow dot). | Image courtesy Jeff Horn
"That particular male cat was not getting food from humans, to my knowledge, but somehow it survived out there amidst coyotes and foxes," Horn said. "It crossed every street in the area where it was trapped. (It navigated) stoplights, parking lots. We found it denning under a softball field during a game."
The owned cats had significantly smaller territories and tended to stay close to home. The mean home range for pet cats in the study was less than two hectares (4.9 acres).
"Still, some of the cat owners were very surprised to learn that their cats were going that far," Horn said. "That's a lot of backyards."
The pet cats managed this despite being asleep or in low activity 97 percent of the time. On average, they spent only 3 percent of their time engaged in highly active pursuits, such as running or stalking prey, the researchers reported. The un-owned cats were highly active 14 percent of the time.
"The un-owned cats have to find food to survive, and their activity is significantly greater than the owned cats throughout the day and throughout the year, especially in winter," Horn said. "These un-owned cats have to search harder to find food to create the (body) heat that they need to survive."
The cats also differed in the types of territories they used throughout the year. Pet cats randomly wandered in different habitats, but un-owned cats had seasonal habits. In winter, feral cats stayed closer to urban areas than expected. And throughout the year they spent a good amount of time in grasslands, including a restored prairie.
Most of the cats in the study stayed within about 300 meters of human structures, said co-author Nohra Mateus-Pinilla, a wildlife veterinary epidemiologist at the Illinois Natural History Survey at Illinois.
"Even feral cats were always within range of a building," she said. "That shows that even though they're feral, they still have a level of dependency on us."
One feral cat chased another out of a dairy barn. Another feral cat waited for a pet cat to emerge each morning and tried to chase it out of its own backyard, Horn said.
The overlap of feral and pet cat territories outdoors spells trouble for the environment, the cats and potentially also for the cat owners, the researchers said.
In an earlier study, co-author Richard Warner, an emeritus professor of natural resources and environmental sciences at Illinois, followed the cats of about two-dozen rural residences over several years.
"Two of the leading causes of cat deaths in that study were other cats and disease," Warner said. "And both of these leading causes of death are sitting here waiting for these owned cats outdoors."
Cats also get diseases from wildlife or other cats, Mateus-Pinilla said, and can bring them home and infect their owners and other pets.
"For example, *Toxoplasma gondii*, a parasite spread primarily by cats, may cause neurological, reproductive and even respiratory problems in humans, cats and wildlife, depending on the species affected," she said.
Rabies, cat scratch fever, feline leukemia and feline immunodeficiency virus are also of concern to pet owners whose cats encounter other cats outdoors, she said. Vaccination of pet cats will reduce but not eliminate the threat of disease transmission, she said.
Even though pet cats have relatively small ranges and are active only in short bursts, Warner said, their impact on wildlife in the immediate vicinity of their homes is likely much more intense than that of a feral cat that wanders over a larger territory.
Unlike other feline predators, such as bobcats, that are native to the Midwest, domestic cats are invasive species that have a disproportionately damaging effect on wildlife -- either through predation or disease, Horn said.

Wild animals that have adapted to ecosystems that are already fragmented, such as the prairies of Central Illinois, are even more endangered because domestic cats are disrupting the ecosystem by hunting, competing with native predators or spreading disease, he said.
Illinois Natural History Survey mammalian ecologist Edward Heske also contributed to this study.
The survey is a unit within the Prairie Research Institute. This study was funded by the survey, the department of natural resources and environmental sciences and U. of I. Extension.

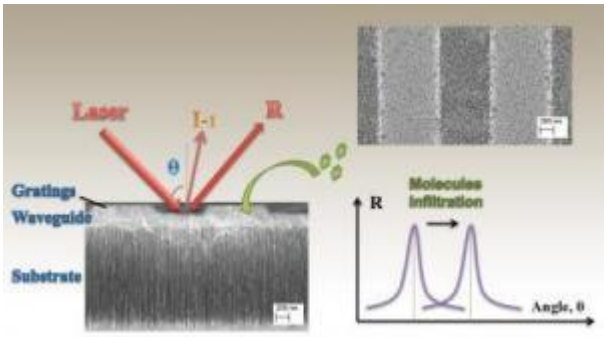
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of Illinois at Urbana-Champaign**.

Journal Reference:

1. Jeff A. Horn, Nohra Mateus-Pinilla, Richard E. Warner, Edward J. Heske. **Home range, habitat use, and activity patterns of free-roaming domestic cats**. *The Journal of Wildlife Management*, 2011; DOI: 10.1002/jwmg.145

http://www.sciencedaily.com/releases/2011/05/110526114531.htm

Improving DNA Sequencing: Sponge-Like Biosensor Crams Enormous Power Into Tiny Space



This figure shows how the sensor works. Light comes into the sensor at a particular angle. Part of the light is then reflected out (R), while part of it is diffracted into the porous silicon "waveguide," where it interacts with the material and is then diffracted out at a different angle (I-1), due to the periodicity of the gratings bumps. When molecules (shown in green) are infiltrated inside the porous material's holes, they interact with the diffracted light. At the lower right of the figure, an optical signal shows peaks that represent the particular angle for the diffracted beam. Shifts in these peaks can be monitored to reveal how many molecules have infiltrated into the sensor. (Credit: Vanderbilt University)

ScienceDaily (May 27, 2011) — Vanderbilt University engineers have created a "spongy" silicon biosensor that shows promise not only for medical diagnostics, but also for the detection of dangerous toxins and other tiny molecules in the environment. This innovation was originally designed to detect the presence of particular DNA sequences, which can be extremely helpful in identifying whether or not a person is predisposed to heart disease or certain kinds of cancer. The new sensor is described in the Optical Society's open access journal, *Optics Express*.

Biological chemical sensors save lives by detecting dangerous substances in the environment or specific molecules in the blood that could signal life-threatening diseases. Current sensor technologies, however, are limited because of their large size compared to the extremely minute sizes of some of the chemicals to be detected. In most cases, when attempting to sense something very small with a large sensor, the small molecules don't perturb the sensor's properties enough for detection.

As Vanderbilt University's Xing Wei, a graduate student, and Sharon M. Weiss, an associate professor of electrical engineering and physics, report in *Optics Express*, it's possible to eliminate this challenge by making sensors with features that are comparative in size to the molecules being detected, greatly increasing the sensitivity of current sensing technology.

To do this, the engineers turned to a porous silicon material, which acts essentially as a small sponge that can then be "seeded" or filled with all sorts of substances that change its properties -- resulting in a detector that's highly sensitive to small molecules. Capturing a particular sequence of DNA involves seeding the sensor with a single strand of DNA, so that only the complementary strand can attach to it and everything else gets rinsed away.

Why use a porous silicon material? Weiss and Wei stress the significance of their new sensor's enormous surface area relative to its small size. To illustrate this point, Weiss describes two cubes, one of which is 3 cm on a side, with a flat surface that DNA can be attached to -- providing 54 cm2 of available surface area to attach these molecules. The other is an identical-size cube, made into a porous silicon sponge and with the ability to access the volume of the cube with all of the internal surface area, providing a surface area that is nearly 10,000 times greater than the first cube. This is like comparing the area of a golf ball to the area of a football field -- with the same footprint. "It's an enormous increase in the potential of how many molecules you can capture, and this is one reason why our new sensor is so much more sensitive for detecting small molecules," says Weiss.

And by using a "grating," a type of surface texturing of the porous silicon commonly used in sensors of this type, light can be delivered in a very simple and compact way to probe the change in the sensor's properties to determine whether or not any molecules of interest have been captured.

"If you look at a CD or a DVD in the light, you'll notice lots of colors bounce off it in room light. The way these discs work is that there are a bunch of bumps, which are very similar to our gratings," says Weiss. When light interacts with a particular arrangement of bumps, the engineers can essentially tell the light what to do, enabling readout of the music or videos on the disc.

That's precisely what the Vanderbilt team has done with their sensor -- put bumps on top of it to control how the light interacts with their active sensing medium (the porous silicon "waveguide"). Then they can determine what the signal means based either on the color that comes out or by the angle of light as it exits the sensor.

"When we infiltrate the molecules that we want to detect and they stay in the sensor and attach, they change the optical density of the porous silicon and, consequently, the angle or the color of light that comes back out," Weiss elaborates. "By knowing how much the angle changes, for example, we can quantify how many molecules are present. So not only can we identify our DNA sequence or toxin, but we can also know how much is present as well. For diagnostics, it's very helpful to know how much is present."

Other potential applications beyond DNA sensing may include detecting small molecules -- such as toxins in the environment -- which has significant national security implications.

Story Source:

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

Journal Reference:

1. Xing Wei and Sharon M. Weiss. **Guided mode biosensor based on grating coupled porous silicon waveguide**. *Optics Express*, Volume 19, Issue 12, pp. 11330-11339 [link]

http://www.sciencedaily.com/releases/2011/05/110526103008.htm

NASA Is Making Hot 'Way Cool'

Close-up of pump being tested on a Terrier-Improved Orion sounding rocket mission from the Wallops Flight Facility in June. (Credit: NASA)

ScienceDaily (May 27, 2011) — The more advanced the electronics, the more power they use. The more power they use, the hotter they get. The hotter they get, the more likely they'll overheat. It doesn't take a rocket scientist to understand what typically happens next: The electronics fry.

In the world of electronics, thermal control is always one of the limiting factors -- particularly in space where there is no air to help cool down electronic components.

However, Jeffrey Didion, a thermal engineer at the NASA Goddard Space Flight Center in Greenbelt, Md., and Dr. Jamal Seyed-Yagoobi, a professor at the Illinois Institute of Technology in Chicago, Ill., have collaborated to develop a technology that may overcome current limitations. They have formed technical partnerships with the U.S. Air Force and National Renewable Energy Laboratory to address the thermal-control concerns.

Called electrohydrodynamic (EHD)-based thermal control, the technology promises to make it easier and more efficient to remove heat from small spaces -- a particular challenge for engineers building advanced space instruments and microprocessors that could fail if the heat they generate is not removed.

"Today, higher-power computer chips are available, but they generate too much heat," said Didion, who is leading the technology-development effort also involving Matthew Showalter, associate branch chief of Goddard's Advanced Manufacturing Branch, and Mario Martins of Edge Space Systems, an engineering company specializing in thermal systems in Glenelg, Md. "If I can carry away more heat, engineers will be able to use higher-power components. In other words, they will be able to do more things."

The project, a joint activity between NASA Goddard and its partners, received support from the Goddard Internal Research and Development (IRAD) program, which funds the development of promising new technologies that could advance NASA's scientific and exploration goals. It is being demonstrated in June on a Terrier-Improved Orion sounding rocket mission, which also is flying the Small Rocket/Spacecraft Technology (SMART) platform, a microsatellite also developed at Goddard. This new microsatellite measures about 16 inches in diameter and was specifically designed to give scientific users less expensive access to space.

The main objective of the EHD demonstration is showing that a prototype pump can withstand the extreme launch loads as the rocket lifts off and hurtles toward space. Should it survive the vibration, the technology will have achieved a major milestone in its development, Didion said. It will mean that it is at or near operational status, making it a viable technology for use on spaceflight instruments.

"Any electronic device that generates a lot of heat is going to benefit from this technology," said Ted Swanson, assistant chief for technology for Goddard's Mechanical Systems Division. This could include everything from sensors flown in space to those used in automobiles and aircraft.

No Moving Parts

The technology promises significant advantages over more traditional cooling techniques. Unlike current technologies used today by instrument and component developers, EHD does not rely on mechanical pumps and other moving parts. Instead, it uses electric fields to pump coolant through tiny ducts inside a thermal cold plate. From there, the waste heat is dumped onto a radiator and dispersed far from heat-sensitive circuitry

that must operate within certain temperature ranges. "Its architecture, therefore, is relatively straightforward," Didion said. Electrodes apply the voltage that pushes the coolant through the ducts.
"The advantages are many," he added. "Without mechanical parts, the system is lighter and consumes less power, roughly half a watt. But perhaps more importantly, the system can be scaled to different sizes, from larger cold plates to microscale electronic components and lab-on-a-chip devices."
In addition to flying the technology on the sounding rocket mission, the EHD development team will fly a prototype EHD cold plate as an experiment on the International Space Station in 2013. "This effort will demonstrate the long-term operation of an EHD thermal-control system," Didion said.

Lab-on-a-Chip Devices

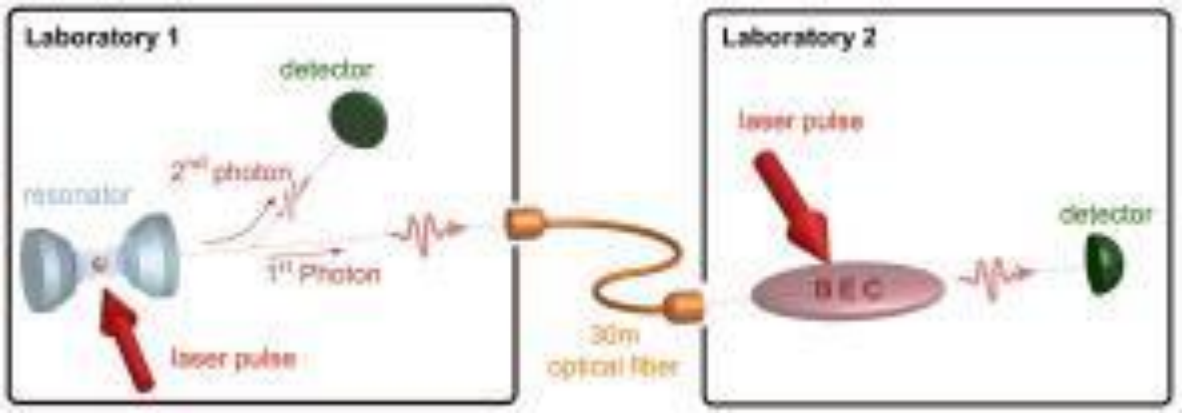
In the meantime, the team is continuing its work to further advance EHD, Didion said. The team is working with Goddard detector engineer Timothy Miller to develop EHD pumps in microchannels that are etched onto silicon wafers. They plan to further experiment with other substrate and composite materials as well as special micro-fabrication techniques and coatings to create smaller, more robust EHD pumps.
These multifunctional devices could be used as stand-alone, off-the-shelf components ideal for quick-turnaround spacecraft -- a capability that particularly interests the Air Force -- or as units embedded within the walls of the electronic device.
The next step is placing the technology on circuit cards, with the ultimate goal of scaling it to the chip level where the ducts would be no larger than 100 microns (0.0039 inch), or about the width of a human hair. "The point is that you want to place the thermal-control unit closer to the source of heat," Didion said. "This would be a lot more efficient at eliminating waste heat."
For more information, visit: http://gsfctechnology.gsfc.nasa.gov/HotWayCool.html

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/2011/05/110526205105.htm

Matter-Matter Entanglement at a Distance: Quantum Mechanical Entanglement of Two Remote Quantum Systems



A single atom and a BEC in two separate laboratories serve as nodes in a basic quantum net-work. To prepare entanglement between these systems, a laser pulse is used to stimulate the atom to emit a single photon which is entangled with the single atom. The photon is used to transport the entanglement through an optical fibre into a neighbouring laboratory. Here, the photon is stored in the BEC. This procedure establishes entanglement between the single atom and the BEC. After some delay, the photon is retrieved from the BEC and the state of the single atom is mapped onto a second photon. The observation of entanglement between these two photons proves that all steps of the experiment were performed successfully. (Credit: G. Rempe)

ScienceDaily (May 27, 2011) — Because of its strange consequences the quantum mechanical phenomenon of entanglement has been called "spooky action at a distance" by Albert Einstein. For several years physicists have been developing concepts how to use this phenomenon for practical applications such as absolutely safe data transmission. For this purpose, the entanglement which is generated in a local process has to be distributed among remote quantum systems.

A team of scientists led by Prof. Gerhard Rempe, Director at the Max Planck Institute of Quantum Optics and head of the Quantum Dynamics Division, has now demonstrated that two remote atomic quantum systems can be prepared in a shared "entangled" state (*Physical Review Letters*, Advance Online Publication, May 26, 2011): one system is a single atom trapped in an optical resonator, the other one a Bose-Einstein condensate consisting of hundreds of thousands of ultracold atoms. With the hybrid system thus generated, the researchers have realized a fundamental building block of a quantum network.

In the quantum mechanical phenomenon of "entanglement" two quantum systems are coupled in such a way that their properties become strictly correlated. This requires the particles to be in close contact. For many applications in a quantum network, however, it is necessary that entanglement is shared between two remote nodes ("stationary" quantum bits). One way to achieve this is to use photons ("flying" quantum bits) for transporting the entanglement. This is somewhat analogous to classical telecommunication, were light is used to transmit information between computers or telephones. In the case of a quantum network, however, this task is much more difficult as entangled quantum states are extremely fragile and can only survive if the particles are well isolated from their environment.

The team of Professor Rempe has now taken this hurdle by preparing two atomic quantum systems located in two different laboratories in an entangled state: on the one hand a single rubidium atom trapped inside an optical resonator formed by two highly reflective mirrors, on the other hand an ensemble of hundreds of thousands of ultracold rubidium atoms which form a Bose Einstein condensate (BEC). In a BEC, all particles have the same quantum properties so that they all act as a single "superatom."

First, a laser pulse stimulates the single atom to emit a single photon. In this process, internal degrees of freedom of the atom are coupled to the polarisation of the photon, so that both particles become entangled. The photon is transported through a 30 m long optical fibre into a neighbouring laboratory where it is directed to the BEC. There, it is absorbed by the whole ensemble. This process converts the photon into a collective

excitation of the BEC. "The exchange of quantum information between photons and atomic quantum systems requires a strong light-matter interaction," explains Matthias Lettner, a doctoral student working on the experiment. "For the single atom, we achieve this by multiple reflections between the two resonator mirrors, whereas for the BEC the light-matter interaction is enhanced by the large number of atoms."
In a subsequent step, the physicists prove that the single atom and the BEC are really entangled. To this end, the photon absorbed in the BEC is retrieved with the help of a laser pulse and the state of the single atom is read out by generating a second photon. The entanglement of the two photons reaches 95 % of the maximally possible value, thus showing that the entanglement of the two atomic quantum systems must have been equally good, or even better. Moreover, the entanglement is detectable for approximately 100 microseconds. "A BEC is very well suited as a quantum memory because this exotic state does not suffer from any disturbances caused by thermal motion," says Matthias Lettner. "This makes it possible to store and retrieve quantum information with high efficiency and to conserve this state for a long time."
In this experiment, the team of Professor Rempe has realized a building block for a quantum network consisting of two remote, entangled, stationary nodes. This is a milestone on the way to large-scale quantum networks in which, for example, quantum information can be transmitted absolutely safe. In addition, such networks might help realizing a universal quantum computer in which quantum bits can be exchanged with photons between nodes designed for information storage and processing.

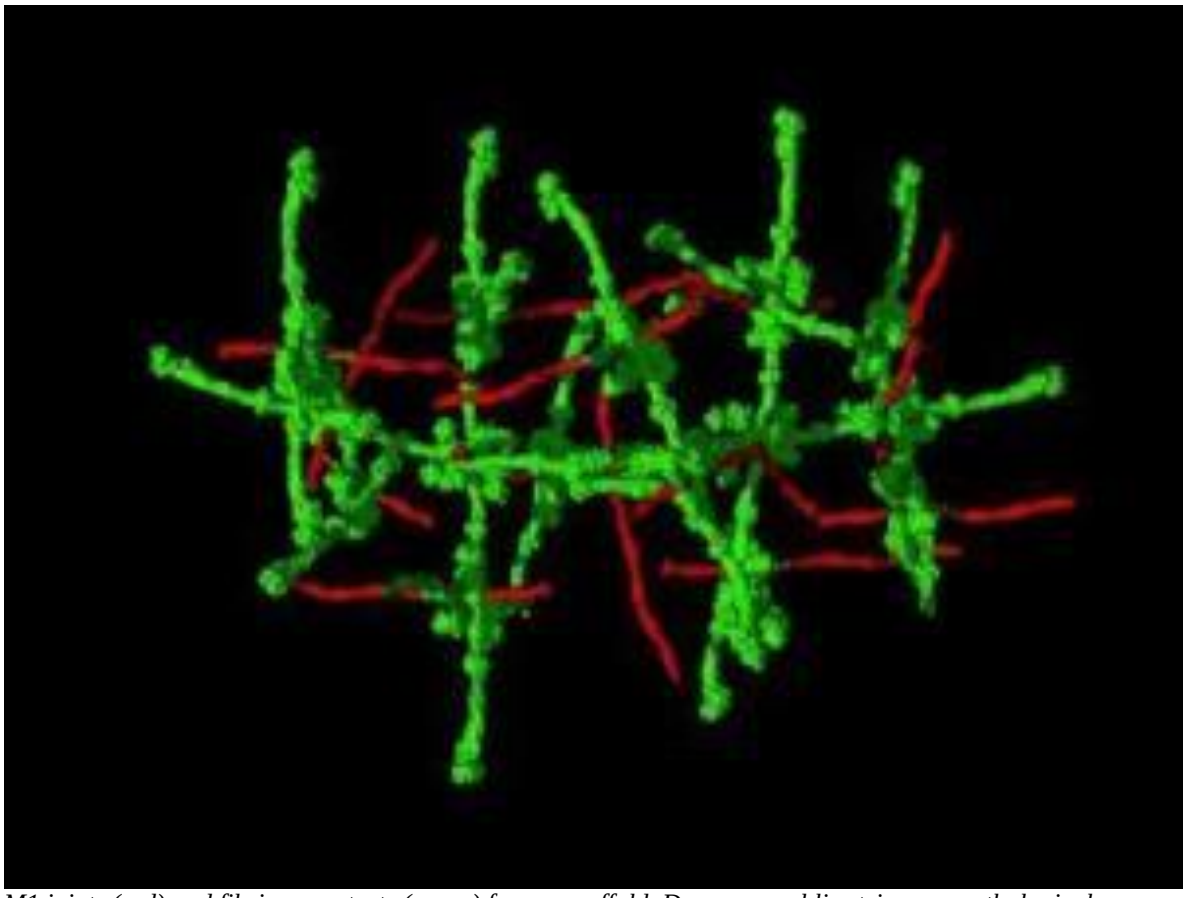
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Max Planck Institute of Quantum Optics**, via AlphaGalileo.

Journal Reference:

1. M. Lettner, M. Mücke, S. Riedl, C. Vo, C. Hahn, S. Baur, J. Bochmann, S. Ritter, S. Dürr, and G. Rempe. **Remote Entanglement between a Single Atom and a Bose-Einstein Condensate**. *Physical Review Letters*, 2011; DOI: 10.1103/PhysRevLett.106.210503

http://www.sciencedaily.com/releases/2011/05/110526204955.htm

Structure Formed by Strep Protein Can Trigger Toxic Shock



M1 joints (red) and fibrinogen struts (green) form a scaffold. Dense assemblies trigger a pathological response that can lead to toxic shock. (Credit: Partho Ghosh lab/UC San Diego)

ScienceDaily (May 27, 2011) — Infection with some strains of strep turn deadly when a protein found on their surface triggers a widespread inflammatory reaction. In a report published April 7 in the journal *Nature*, researchers describe the precise architecture of a superstructure formed when the bacterial protein called M1 links with a host protein, fibrinogen, that is normally involved in clotting blood.

The proteins form scaffolds with M1 joints and fibrinogen struts that assemble into dense superstructures. Frontline immune cells called neutrophils mistake these thick networks for blood clots and overreact, releasing a chemical signal that can dilate vessels to the point where they leak, the team reports.

"We knew that M1 plus fibrinogen was inflammatory, but how was unknown. By determining the structure of this complex, we were able to identify the characteristics that lead to a sepsis response," said Partho Ghosh, Ph.D., professor of chemistry and biochemistry at the University of California, San Diego who studies the structure of virulence factors and led this project.

Ghosh and colleagues found that the density of the M1-fibrinogen structure was a critical characteristic. Looser structures or separate fibers formed by altered versions of M1 failed to trigger a pathological response.

"This research provides the first snapshot of the interaction between this key bacterial virulence factor and its human target at the atomic level," said Victor Nizet, M.D., professor of pediatrics and pharmacy and a co-author of the report.

Difficult to treat once they set in, the leaking blood vessels and organ failure of strep-induced toxic shock prove fatal for 30 percent of patients. Ghosh and Nizet have a long-standing collaboration aimed at designing treatments to counteract the toxic effects of strep protein.

Additional co-authors include Pauline Macheboeuf and Cosmo Buffalo of the department of chemistry and biochemistry, Annelies Zinkernagel and Jason Cole of the department of pediatrics, and Chi-yu Fu and Jack Johnson of The Scripps Research Institute. The National Institutes of Health funded this work.

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

Journal Reference:

1. Pauline Macheboeuf, Cosmo Buffalo, Chi-yu Fu, Annelies S. Zinkernagel, Jason N. Cole, John E. Johnson, Victor Nizet, Partho Ghosh. **Streptococcal M1 protein constructs a pathological host fibrinogen network**. *Nature*, 2011; 472 (7341): 64 DOI: 10.1038/nature09967

http://www.sciencedaily.com/releases/2011/04/110406131800.htm

Superior Sound for Telephones, Mobile and Related Devices

With audio coding technologies, Marc Gayer, Manfred Lutzky and Markus Schnell (from left to right), were able to considerably improve the quality of communication systems. (Credit: Image courtesy of Fraunhofer-Gesellschaft)

ScienceDaily (May 27, 2011) — Telephone calls and video conferences with a sound quality that approaches that of direct communication are now possible with a new audio coding technology -- it is almost as if the discussion participants are sitting across from one another.

MP3 for phone calls -- Considering the poor sound quality of many phone calls, this is a great idea. Videoconference phone calls in particular can be unintentionally awkward because the participants start to speak at the same time due to the time delay in the transmission. The reasons for this are long delay times and the poor quality of today's video calls. Fraunhofer's task was therefore to improve the quality and simultaneously minimize the delay time. The technology that makes this possible is called Enhanced Low Delay Advanced Audio Coding, in short, AAC-ELD. It was developed by Manfred Lutzky, Marc Gayer, Markus Schnell and their team from the Fraunhofer Institute for Integrated Circuits IIS in Erlangen.

Fraunhofer IIS is known as the main inventor of MP3, the audio codec that made it possible to greatly reduce the size of music or other audio files without impairing the sound. To implement something similar for the telephone and other devices was easier said than done. "The algorithm requires a certain amount of time to encode the data and to decode it again at the other end of the line. The process requires data that is still in the future, as it must wait for the data to arrive. This can result in a situation where interactive communication is very difficult," explained Markus Schnell.For several years, the IIS team continued to improve the algorithm even further to shorten the delay and not impair the quality at the same time. The solution, "We attempted to further minimize the area that is forward-looking and to only process current data. We did that until we found an optimum balance between quality and delay," said Schnell.

One technology -- many applications

The results are audibly good as the delay with Enhanced Low Delay AAC is only about 15 milliseconds. During this extremely short timespan, the algorithm manages to reduce the audio data to less than one-thirtieth of its original volume without major losses of sound quality. Due to its enormous performance capacity, the coding process has already prevailed in many areas. Marc Gayer explains, "Currently, AAC Low Delay, the forerunner of AAC-ELD, is the actual standard for many video-conferencing systems. But the process is also increasingly applied in radio broadcasts, for example for live sports reports."

The advantage of improved speech transmission is also heard in mobile devices, such as the iPhone4 and in the iPad2, for example. Video telephone transmissions in particular are supported in these devices. The

developers created a very special application was to promote the communication between groups that are socially close to each other. A system was created that makes it possible to play games across the borders of cities or countries. "Thanks to the optimized image and sound quality, there is the impression that game partners who are far apart from each other are not in front of screens, but actually sitting across from one another," said Manfred Lutzky.

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/2011/05/110526091254.htm

Medicines from Plants

Dr. Jürgen Drossard, Dr. Thomas Rademacher and Dr. Stefan Schillberg (from left to right) produce active substances in transgenic plants and plant suspension cells. (Credit: Copyright Dirk Mahler)

ScienceDaily (May 27, 2011) — "Medicines from plants" -- one thinks of herbal teas or valerian drops. However, that has nothing in common with what the researchers at the Fraunhofer Institute for Molecular Biology and Applied Ecology IME in Aachen, Germany, are doing. They use plants to produce biopharmaceuticals. These are proteins that, unlike many other medications, cannot be chemically produced. Biologically produced medications, such as recombinant insulin or therapeutic antibodies to fight cancer, have become indispensable. Plants are particularly suitable for producing complex active substances. The reason is that these substances can be produced inexpensively and on a large scale in plants. Compared to producing them in animal cells, plants have the advantage that they grow quickly, are easy to look after and can be protected well against damaging influences.

Precisely controlled raising of plants

Tobacco was the plant of choice. Dr. Jürgen Drossard explains the reason: "Tobacco has long been a very interesting plant for molecular biologists. It is easy to modify, meaning a foreign gene coding for the pharmaceutical protein can be introduced. In addition, a lot of biomass grows quickly and therefore a greater quantity of the desired proteins is also produced." The active substances must be absolutely safe. It is for this reason that the requirements both for growing the plants and for the processes and equipment for the preparations are particularly high. The researchers from Aachen passed the stringent tests of the supervisory and approval authorities for both. "The tobacco plants are protected from all external influences and grown under precisely controlled conditions. We practically grow them on sterile substrates. And fertilization with manure is absolutely out of the question, of course," says Dr. Thomas Rademacher.

But growing the plants only solved a part of the problem. Because, how does one get as much protein as possible from the leaves that are harvested? The team developed the equipment that is suitable for that itself,

because current processes, coming from food technology, for example, work on an entirely different scale. The complete pulping process now takes place in a closed loop.

Biopharmaceuticals for clinical studies

"We wanted to show that it can be done, that biopharmaceuticals can be produced that are suitable for clinical studies," says Dr. Stefan Schillberg of the IME. And this is exactly where the team is at with its development. The proteins that are produced in this manner are currently being tested with the objective that they be used in clinical studies. For example, the antibodies could be used to manufacture a vaginal gel with which women could protect themselves from an HIV infection. In a new project, the researchers are currently working on producing a malaria vaccine in plants.

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/2011/05/110526102759.htm

Assessing the Influence of Alaska Glaciers Is Slippery Work

Glacier Bay National Park, Alaska. (Credit: © virsuziglis / Fotolia)

ScienceDaily (May 27, 2011) — With an estimated 34,000 square miles of ice, an area about the size of Maine, Alaska's multitude of glaciers have a global impact.

Anthony Arendt, an assistant research professor at the University of Alaska Fairbanks Geophysical Institute, has outlined the complexity and influence of Alaska glaciers in this week's issue of the journal *Science*. In his article, Arendt explains the importance of integrating field observations and more precise glacier simulation models.

"We have used satellites to measure the mass changes of all of Alaska's glaciers, but there are also many glaciers that need to be measured in the field," Arendt said. "We need these field observations to better understand the processes that are controlling glacier changes."

Glacial patterns are difficult to predict -- even for current computer models. Alaska glaciers often behave independently of one another. They retreat and surge, and are subject to volcanic and oceanic influences, in addition to changes in precipitation and warming temperatures. Data collected in the field will help refine existing models, so that a more accurate picture of changing sea level can be drawn.

"Alaska glaciers have been losing mass more rapidly since the mid-1990s than they were several decades earlier," Arendt states in the article. "Understanding whether this trend continues will require an integration of observations across disciplines, as well as the development of robust glacier simulation models."

According to Arendt, glaciers and ice caps make up a mere three percent of the ice on our planet, yet they account for about half of the sea level contribution. These dynamic chunks of ice are tremendously influential on future coastlines.

"There are many people living very close to the sea in areas where even a small change in sea level would be devastating," Arendt said. "Developing countries don't have the resources to deal with this change."

To create the best sea level forecasts, Arendt said that scientists need to use field observations to fill data gaps in current models. With thousands of glaciers in Alaska, scientists have much more work to do, he said, noting that the research will ultimately help the global community better adapt to sea level change.

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

Journal Reference:

1. A. A. Arendt. **Assessing the Status of Alaska's Glaciers**. *Science*, 2011; 332 (6033): 1044 DOI: 10.1126/science.1204400

http://www.sciencedaily.com/releases/2011/05/110527162507.htm

Changes in Brain Circuitry Play Role in Moral Sensitivity as People Grow Up

Researchers showed video clips that portrayed intentional and accidental harm, and found that all participants, irrespective of their age, paid more attention to people being harmed and to objects being damaged than they did to the perpetrators. (Credit: Jean Decety)

ScienceDaily (May 27, 2011) — People's moral responses to similar situations change as they age, according to a new study at the University of Chicago that combined brain scanning, eye-tracking and behavioral measures to understand how the brain responds to morally laden scenarios.

Both preschool children and adults distinguish between damage done either intentionally or accidently when assessing whether a perpetrator had done something wrong. Nonetheless, adults are much less likely than children to think someone should be punished for damaging an object, especially if the action was accidental, said study author Jean Decety, the Irving B. Harris Professor in Psychology and Psychiatry at the University of Chicago and a leading scholar on affective and social neuroscience.

The different responses correlate with the various stages of development, Decety said, as the brain becomes better equipped to make reasoned judgments and integrate an understanding of the mental states of others with the outcome of their actions. Negative emotions alert people to the moral nature of a situation by bringing on discomfort that can precede moral judgment, and such an emotional response is stronger in young children, he explained.

"This is the first study to examine brain and behavior relationships in response to moral and non-moral situations from a neurodevelopmental perspective," wrote Decety in the article, "The Contribution of Emotion and Cognition to Moral Sensitivity: A Neurodevelopmental Study," published in the journal *Cerebral Cortex*. The study provides strong evidence that moral reasoning involves a complex integration between affective and cognitive processes that gradually changes with age.

For the research, Decety and colleagues studied 127 participants, aged 4 to 36, who were shown short video clips while undergoing an fMRI scan. The team also measured changes in the dilation of the people's pupils as they watched the clips.

The participants watched a total of 96 clips that portrayed intentional harm, such as someone being shoved, and accidental harm, such as someone being struck accidentally, such as a golf player swinging a club. The clips also showed intentional damage to objects, such as a person kicking a bicycle tire, and accidental damage, such as a person knocking a teapot off the shelf.

Eye tracking in the scanner revealed that all of the participants, irrespective of their age, paid more attention to people being harmed and to objects being damaged than they did to the perpetrators. Additionally, an analysis of pupil size showed that "pupil dilation was significantly greater for intentional actions than accidental actions, and this difference was constant across age, and correlated with activity in the amygdala and anterior cingulate cortex," Decety said.

The study revealed that the extent of activation in different areas of the brain as participants were exposed to the morally laden videos changed with age. For young children, the amygdala, which is associated the generation of emotional responses to a social situation, was much more activated than it was in adults.

In contrast, adults' responses were highest in the dorsolateral and ventromedial prefrontal cortex -- areas of the brain that allow people to reflect on the values linked to outcomes and actions.

In addition to viewing the video clips, participants were asked to determine, for instance, how mean was the perpetrator, and how much punishment should he receive for causing damage or injury. The responses showed a clear connection between moral judgments and the activation the team had observed in the brain. "Whereas young children had a tendency to consider all the perpetrator malicious, irrespective of intention and targets (people and objects), as participants aged, they perceived the perpetrator as clearly less mean when carrying out an accidental action, and even more so when the target was an object," Decety said. When recommending punishments, adults were more likely to make allowances for actions that were accidental, he said. The response showed that they had a better developed prefrontal cortex and stronger functional connectivity between this region and the amygdala than children. Adults were better equipped to make moral judgments. "In addition, the ratings of empathic sadness for the victim, which were strongest in young children, decreased gradually with age, and correlated with the activity in the insula and subgenual prefrontal cortex," which area areas associated with emotional behavior and automatic response to stresses, Decety said. Together, the results are consistent with the view that morality is instantiated by functionally integrating several distributed areas/networks.

The research was supported with a grant from the National Science Foundation. Joining Decety in writing the paper were Kalina Michalska, a postdoctoral scholar, and Katherine Kinzler, an assistant professor, both in the Department of Psychology.

Story Source:

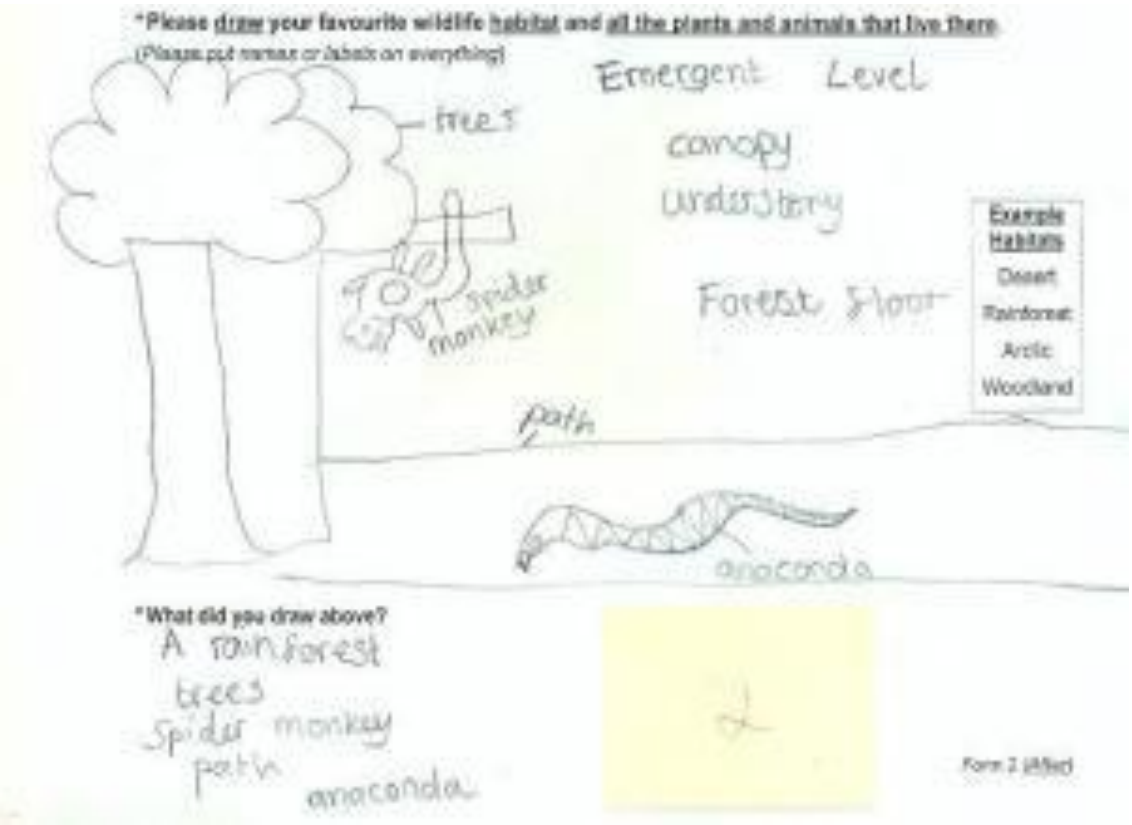
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of Chicago**.

Journal Reference:

1. J. Decety, K. J. Michalska, K. D. Kinzler. **The Contribution of Emotion and Cognition to Moral Sensitivity: A Neurodevelopmental Study**. *Cerebral Cortex*, 2011; DOI: 10.1093/cercor/bhr111

http://www.sciencedaily.com/releases/2011/05/110527162504.htm

A Visit to a Zoo Boosts Science and Environment Knowledge



The children were asked to draw their favourite animals and habitats before and after their trip to the zoo. The drawings were analysed and showed some remarkable improvements. Some 51% of ten-year-olds showed a real change in the drawings and the use of correct scientific terms such as 'canopy' and 'rainforest' and had a higher amount of animals placed in the correct habitat, e.g. a meerkat drawn in the desert. (Credit: Image courtesy of University of Warwick)

ScienceDaily (May 27, 2011) — Research from the University of Warwick shows a trip to the zoo can boost your child's science and conservation education more than books or classroom teaching alone.

In research conducted at ZSL London Zoo, more than 3,000 school children aged between seven and 14 were asked about their knowledge of animals, habitat and conservation and then tested again after their trip.

The results show that 53% had a positive change in educational or conservation-related knowledge areas, personal concern for endangered species or new empowerment to participate in conservation efforts. The study proves that their trip around the zoo provided a statistically significant increase in scientific learning about animals and habitats. When zoo visits were supplemented by an educational presentation by zoo staff this increase in learning almost doubled against self-guided visits.

Eric Jensen, a Professor of Sociology at the University of Warwick, who produced the report said: "Globally, more than a tenth of the world's population passes through zoos annually so the potential is there to reach a huge audience.

"In recent years zoos have come under criticism for failing to demonstrate educational impact with certain lobbying groups arguing that it's cruel to keep animals captive. But zoos have been changing for years now to offer more educational and conservation information; 'behind the scenes' access for visitors; learning about habitat conservation work -- all of which culminate in a better engagement experience for the visitor."

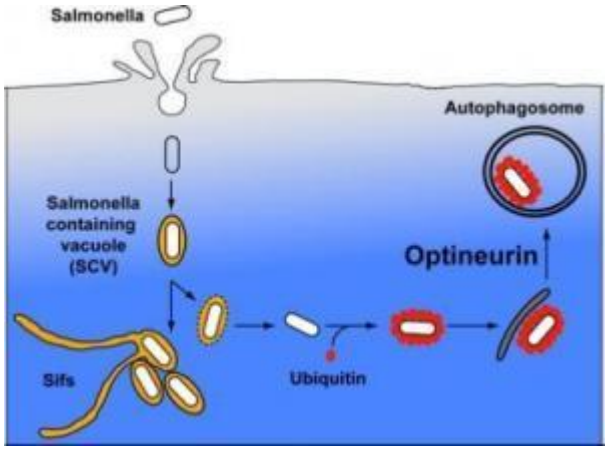
Children came away with a greater understanding of ideas such as conservation, habitat and extinction. Amongst those who had not previously registered a concern about species extinction, 39% switched to registering such a concern directly after a zoo trip.

The children were asked to draw their favourite animals and habitats before and after their trip to the zoo. The drawings were analysed and showed some remarkable improvements. Some 51% of ten-year-olds showed a real change in the drawings and the use of correct scientific terms such as 'canopy' and 'rainforest' and had a higher amount of animals placed in the correct habitat, e.g. a meerkat drawn in the desert.
Eric added: "The research clearly shows the valuable role that zoos can play in children's science learning. So with another Bank Holiday fast approaching, why not swap the theme park for a good zoo? Your kids and their favourite animals may thank you in years to come!"
Full report.

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

http://www.sciencedaily.com/releases/2011/05/110527101510.htm

Intestinal Cell Defense Mechanism Against Bacteria: Molecular Mechanism of Selected Autophagy Elucidated



Scheme of Salmonella infection and clearance via autophagy pathway. The critical intracellular signals are ubiquitin that decorates Salmonella and Optineurin that acts as an autophagy receptor critical for targeting of Salmonella to the degradation in the lysosome. (Credit: Ivan Dikic)

ScienceDaily (May 27, 2011) — Salmonella is widely prevalent in the animal kingdom. The reason we do not suffer from severe intestinal infections very often is due to our body's defence system, which manages to digest invading bacteria. This is why, generally speaking, a healthy human being will only fall ill if he consumes more than 100.000 salmonella bacteria via a contaminated food source, such as eggs or meat.

An international team of researchers, led by Prof. Ivan Dikic from the Goethe University in Frankfurt has now found out how body cells recognise salmonella and render it harmless. Understanding this process at a molecular level is crucial in identifying new targets for treatment. Tropical and sub-tropical countries in particular, where various sub-species of salmonella are common, are experiencing a rapid increase in resistance to antibiotics, with children at greatest risk.

Salmonella infection begins with bacteria entering the epithelial cells of the intestinal mucosa. To prevent them multiplying there, special cell organelles, called autophagosomes are activated. These encircle the invaders and then become absorbed in other organelles -- lysosomes -- that contain certain special digestive enzymes, which break down the bacteria into their constituent parts. But how exactly do the autophagosomes recognise salmonella? Prof. Ivan Dikic and his research group at the Biochemistry Institute II have now shed light on this mechanism.

As reported in a current article in the journal *Science*, the salmonella are marked as 'waste material' by the molecule ubiquitin. In order for the autophagosomes to become active, the marked bacteria have to bind to another molecule -- LC3 -- on the autophagosomal membrane. Here, the protein optineurin plays a key role, linking the marked Salmonella to the autophagosmal LC3, thereby setting off a process of selective autophagy. But optineurin becomes active as a link only after being chemically modified by an enzyme, (in this case it is phosphorylated by the protein kinase TBK1). "We suspect that phosphorylation acts as a regulated switch to trigger selective autophagy of bacteria but might also prove significant in other cargoes like protein aggregates or damaged mitochondria" explains Prof. Ivan Dikic, underlining the importance of these findings. It is thought that impaired autophagy processes may be implicated in, among other things, the development of cancer as well as neurodegenerative diseases.

In the area of infectious diseases, these findings are particularly relevant in view of the fact that gastrointestinal disease caused by Salmonella enterica has rapidly increased since the mid-1980s. In Germany, approx. 30,000 cases were reported to the health authorities in 1985, but by 2005 the figure has risen to 52,000. Worldwide, 94 million people fall ill each year with acute gastroenteritis, and 155,000 of these die. Typhoid, a disease also caused by Salmonella, affects 16 million people annually and mortality rates reach 200,000, with children in particular falling victim to the disease. Bacteria are becoming increasingly resistant to antibiotics so that the potential for treating disease is limited. Chloramphenicol, a formerly popular broad-

spectrum antibiotic, is now ineffective, and even Fluoroquinolones, currently a commonly prescribed antibiotic, is proving inadequate in fighting bacteria. As co-author Prof. Dirk Bumann from the Biozentrum at Basel University puts it: "There is a pressing need to find new forms of treatment for infectious diseases. A better understanding of how the body's own defence mechanism makes use of autophagy will certainly help."

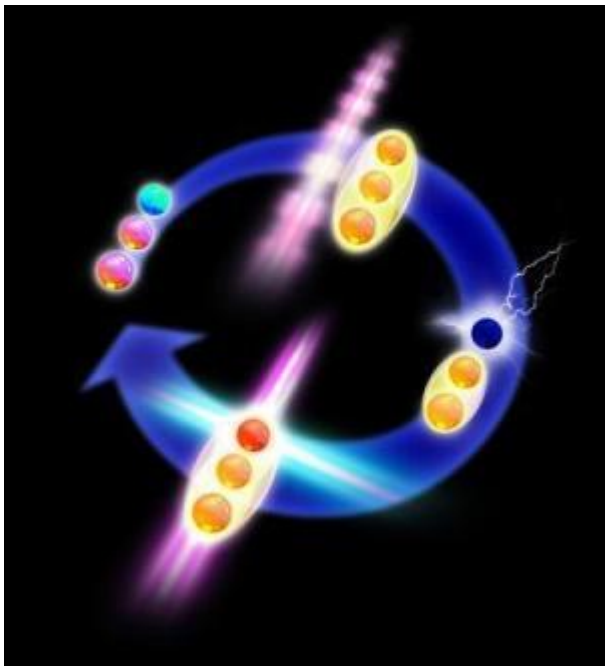
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Goethe University Frankfurt**, via EurekAlert!, a service of AAAS.

Journal Reference:

1. P. Wild, H. Farhan, D. G. McEwan, S. Wagner, V. V. Rogov, N. R. Brady, B. Richter, J. Korac, O. Waidmann, C. Choudhary, V. Dotsch, D. Bumann, I. Dikic. **Phosphorylation of the Autophagy Receptor Optineurin Restricts Salmonella Growth**. *Science*, 2011; DOI: 10.1126/science.1205405

http://www.sciencedaily.com/releases/2011/05/110527101237.htm

The Quantum Computer Is Growing Up: Repetitive Error Correction in a Quantum Processor



The quantum bit (blue) is entangled with the auxiliary qubits (red). If an error occurs, the state of the defective quantum bit is corrected. (Credit: Harald Ritsch)

ScienceDaily (May 26, 2011) — Physicists have demonstrated a crucial element for a future functioning quantum computer: repetitive error correction. This allows scientists to correct errors occurring in a quantum computer efficiently.

A general rule in data processing is that disturbances cause the distortion or deletion of information during data storage or transfer. Methods for conventional computers were developed that automatically identify and correct errors: Data are processed several times and if errors occur, the most likely correct option is chosen. As quantum systems are even more sensitive to environmental disturbances than classical systems, a quantum computer requires a highly efficient algorithm for error correction. The research group of Rainer Blatt from the Institute for Experimental Physics of the University of Innsbruck and the Institute for Quantum Optics and Quantum Information of the Austrian Academy of Sciences (IQOQI) has now demonstrated such an algorithm experimentally.

"The difficulty arises because quantum information cannot be copied," explains Schindler. "This means that we cannot save information repeatedly and then compare it." Therefore, the physicists use one of the peculiarities of quantum physics and use quantum mechanical entanglement to perform error correction.

Quick and efficient error correction

The Innsbruck physicists demonstrate the mechanism by storing three calcium ions in an ion trap. All three particles are used as quantum bits (qubits), where one ion represents the system qubit and the other two ions auxiliary qubits. "First we entangle the system qubit with the other qubits, which transfers the quantum information to all three particles," says Philipp Schindler. "Then a quantum algorithm determines whether an error occurs and if so, which one. Subsequently, the algorithm itself corrects the error." After having made the correction, the auxiliary qubits are reset using a laser beam. "This last point is the new element in our experiment, which enables repetitive error correction," says Rainer Blatt. "Some years ago, American colleagues demonstrated the general functioning of quantum error correction. Our new mechanism allows us to repeatedly and efficiently correct errors."

Leading the field

"For a quantum computer to become reality, we need a quantum processor with many quantum bits," explains Schindler. "Moreover, we need quantum operations that work nearly error-free. The third crucial element is an efficient error correction." For many years Rainer Blatt's research group, which is one of the global leaders

in the field, has been working on realizing a quantum computer. Three years ago they presented the first quantum gate with fidelity of more than 99 percent. Now they have realized another key element: repetitive error correction.
This research work is supported by the Austrian Science Fund (FWF), the European Commission, the European Research Council and the Federation of Austrian Industries Tyrol and is published in the scientific journal *Science*.

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

Journal Reference:

1. Philipp Schindler, Julio T. Barreiro, Thomas Monz, Volckmar Nebendahl, Daniel Nigg, Michael Chwalla, Markus Hennrich, and Rainer Blatt. **Experimental Repetitive Quantum Error Correction**. *Science*, 27 May 2011: Vol. 332 no. 6033 pp. 1059-1061 DOI: 10.1126/science.1203329

http://www.sciencedaily.com/releases/2011/05/110526141501.htm

In for Nasty Weather

May 16, 2011
Maybe it's because tenured professors are so disproportionately white male baby boomers that classic rock seems like a natural way to capture the sense that tenured faculty existence is vanishing.
First, summon the image of a tweed-clad, gray-haired professor exiting the halls of academe at the end of his career -- only to be replaced by an underpaid adjunct, whose credentials and teaching skills may well be far better than those the newly emeritus had when he started. Then, take your pick of the soundtrack. The song spoke to the tenured professor in his youth, but now it conjures a more forlorn feeling as he leaves campus -- and the kind of faculty job that he held leaves along with him: "Slip Slidin' Away," "The Song is Over" or maybe "Already Gone."

In an upcoming post on his blog that is tentatively titled "Full Moon Setting," James C. Garland, president emeritus of Miami University in Oxford, Ohio, reaches for the album-oriented rock catalog (his title is a riff on the Creedence Clearwater Revival song, "Bad Moon Rising").
The song's lyrics seemed apt, he said. "I hear hurricanes a-blowing/I know the end is coming soon/I fear rivers overflowing/I hear the voice of rage and ruin."
"The metaphor in higher education is that the bad moon is rising," Garland told *Inside Higher Ed*. "You're hearing the voices of rage and ruin. It comes from unhappy faculty who want to form unions to protect themselves, declining standards, students who aren't willing to work, the corporatization of the university and the general sense that things are getting worse."
Garland's larger argument is actually more philosophical (and, he said, influenced by his wife's t'ai chi teacher) -- that those in higher education should seek to gracefully manage change rather than pine for a bygone era. "You've got to realize that full moons aren't forever, that the moon rises and sets," he said. "That's just in the nature of things. That seems to be what's happening, particularly to public higher education."
Still, the darker themes implicit in such narratives of decline resonated -- with some exceptions -- among many experts on higher education and the faculty who were recently interviewed by *Inside Higher Ed*.
Faculty members have never been known for being particularly Panglossian, but most of those interviewed noted that things now really do seem to be worse. While the current state of affairs is, in one sense, a reflection of the wider economic shocks that have hit other workers, many of the problems now surfacing pre-date the financial crisis. The erosion of status, stature, and prospects for a future that much resembles the past has occurred for complicated reasons, experts say, including long-term, systemic, external and ideological ones as well as more recent political and economic developments, and some self-inflicted wounds.
"The American professoriate is in the midst of a major transformation, and it will very likely involve permanent changes to this line of work," Joseph C. Hermanowicz, associate professor of sociology at the University of Georgia and editor of the forthcoming book, *The American Academic Profession: Transformation in Contemporary Higher Education* (Johns Hopkins University Press), said in an e-mail.
While he did not foresee the complete obliteration of tenured faculty, Hermanowicz said the trend of tenured and tenure-track faculty lines being replaced by adjuncts will likely continue, which will affect the nature of the university and higher education. "In the future, fewer and fewer people will know the academic life or the academic job that we have known over the past many decades," he said in an interview. "The consequences of that, on the whole, will be an eroded sense of what it means to be a faculty member and what a university faculty member actually is. We're in the midst of that confusion right now."

No Longer at the Center

Examples of the diminished stature of the faculty can be found widely. Governors have stripped public employees, including faculty members, of their collective bargaining rights. Legislatures and state systems of higher education have taken aim at tenure.
As intellectual elites, professors also make tempting targets. Classroom discussions conducted in the once-safe space of campus have been copied and distributed -- and heavily edited -- in what advocates of such

measures tout as a bid for accountability, but that many faculty members see as propagandistic efforts at intimidation.

Others argue that faculty members wield too much power on campus and are too consumed with protecting their narrow interests at the expense of their institutions. Dick Armey, the former majority leader of the U.S. House of Representatives and, as chairman of FreedomWorks, a leading figure in the Tea Party movement, argued last month in the *Houston Chronicle* that universities must be restructured to "eliminate the faculty's iron grip over questions of governance" in order to hand over more authority to administrators, which, he said, would stamp out "cronyism."

And -- even as national politicians and foundations set goals for higher rates of educational attainment in the U.S. and as students grow increasingly diverse -- governors across the country have put higher education on the budgetary chopping block.

"Social, economic and political forces are converging in what you could say is a perfect storm," said Cathy A. Trower, research director of the Collaborative On Academic Careers in Higher Education at Harvard University. "Some would probably argue it's a storm whose time has come."

Faculty have not fared much better within the narrower confines of the campus. Just one-quarter of college presidents surveyed by *Inside Higher Ed* said that their faculty had proven helpful in responding to the economic troubles of the past two years (on par with student government representatives; elected faculty leaders scored slightly higher). The disconnect between faculty and administration was even more pronounced among presidents of private colleges. Asked what changes to campus they would make if not for fear of political blowback, private college presidents listed faculty-related options as their top three choices: mandating the retirement age for older faculty, changing tenure policy and increasing teaching loads.

"What is disturbing today is that it seems a generation of presidents and provosts, not external yahoos, seems bent on diluting one of the defining, strong features of their own universities" -- the centrality of the faculty -- said John R. Thelin, author of *A History of American Higher Education* (Hopkins) and a professor of education at the University of Kentucky.

Implicit in views like Thelin's is the belief that the faculty's stake in colleges and universities is not an esoteric matter, or something to be dismissed as petty self-interest. While few faculty members would deny that they are self-interested on these issues, many would argue that their concerns are quite reasonable when most of the adjunct jobs being created lack job security or health insurance, and adjuncts are given little input into their working conditions or the academic mission of their college. The faculty are at the heart of the institution, wrote Jack H. Schuster and Martin J. Finkelstein in *The American Faculty: The Restructuring of Academic Work and Careers* (Hopkins). "Whatever the distinctive contributions that have been made to societies over time by universities, those contributions are overwhelmingly the work of the faculty through their teaching and scholarship," they wrote.

While many adjuncts argue that they are more skilled instructors because of their larger teaching loads, research also suggests that frequent contact between faculty and students outside the classroom -- the sort of contact for which adjuncts are neither compensated nor equipped in the form of office space -- is a solid predictor of student success. Being on campus also allows faculty members to weigh in on the direction of the institution in the form of shared governance. But that influence is ebbing, said many observers.

"The faculty is not, for the most part, in the center of the enterprise the way it was 20 years ago. We've had a mind shift," said Finkelstein, professor of higher education at Seton Hall University. One example, he said, is that administrative oversight has grown in stature as traditional metrics for accreditation (the number of books in the campus library or the share of doctorates among faculty) have been replaced by a focus on desired outcomes -- outcomes that often are determined without significant faculty input. "It's not that knowledge workers aren't important," said Finkelstein. "It's that knowledge work is so important that we can't leave it to knowledge workers."

But, even amid such distress among the faculty, encouraging signs and counter-examples can be found, said Gary Rhoades, general secretary of the American Association of University Professors. He challenged the view that the faculty have been largely marginalized and that their influence is on the wane. "It's probably not quite as bleak as that," said Rhoades. "There is a lot of organizing, energy and pushback and an effort to create better working conditions for a whole variety of faculty." Rhoades cited recent organizing victories for the AAUP and the American Federation of Teachers at the University of Illinois at Chicago and elsewhere.

Many faculty advocates are fighting back by seeking to reaffirm their role and more aggressively align their fate with that of students -- and their institutions. Faculty members in recent months have rallied alongside students to protest cuts to higher education, and academic labor unions on Tuesday will formally launch a national campaign, previously described here, that seeks to assure a brighter future for higher education.

Neoliberalism Coming Home to Roost

Although the recent stresses on the faculty have grown more evident, the underlying reasons for these changes, say many observers, are more complex and structural.

Attacks on tenure and on the role of the faculty tend to happen not just during times of economic insecurity, but also during periods of political flux -- both of which apply at present, noted several scholars. Added to the mix is a strain of anti-intellectualism and a suspicion of elites. Technology, too, has diminished many traditional avenues of intellectual authority, allowing the uninformed to appear, to the layperson, as well-versed as the expert. "You could say knowledge creation and people's views of that have changed," said Trower, of Harvard. "I'm not a big fan of Wikipedia, but it is information, and I do think it has caused a shift in how people think about what knowledge is and how it can be delivered and how it can be known."

But many agreed that perhaps the largest factor leading to the changed make-up of the faculty has been both slower moving and more consequential: the replacement of tenured faculty with adjuncts. Depending on the estimate, between one-half and two-thirds of the professoriate is composed of faculty members who have no tenure, low pay and little job security.

Thelin, of Kentucky, likened the structural integrity of higher education to a television commercial in which an exterminator tries to stop the spread of termites in a house, only to discover that the foundation has been devoured one morsel at a time, imperceptible to the naked eye. "It's like the man from Orkin: the termite damage won't be evident immediately," he said. "But over time it's going to nibble and nibble and nibble away the foundation of a sound academic institution."

The shift to a contingent workforce has been paralleled by changes that have altered the framework that once supported other highly trained professions, several experts noted. "We aren't the only profession that has had the nature of our job changed," said Gaye Tuchman, professor of sociology at the University of Connecticut and author of *Wannabe U.: Inside the Corporate University* (University of Chicago Press). "You used to have a family doctor who had a practice. There are fewer and fewer solo lawyers," she said. "What I think we have to recognize is that the transformation is not simply a transformation of the academy; there's a general transformation of the workplace."

That wider context doesn't make the reality of the academic job any more palatable to those in academe -- either for those who are in the ranks of the contingent workforce or for tenured professors who are among the beneficiaries of cheap adjunct labor.

"It is appalling to me. We have a two-class system in the American university," said Richard Vedder, distinguished professor of economics at Ohio University. "We have an aristocratic elite -- the tenured class and those who have a reasonable probability of being tenured. On the other hand, we have these adjuncts."

This reliance on adjuncts, said Vedder, is in some cases an outgrowth of the increased institutional emphasis on research -- part of the arms race to boost rankings and prestige. Research output is relatively easy to measure, he said (far more than teaching). More critically, he added, research creates revenue for the institution. "In their zeal to get all this money -- research money -- they're paying more and more to full-time professors and giving them lower teaching loads," he said. "That's one dirty little secret we don't want revealed: as teaching loads have fallen over the last half-century, we faced the little nagging problem that someone needs to teach the students." (Vedder's critique on teaching loads largely applies to more elite institutions -- and wouldn't make much sense to faculty at community colleges and access-oriented four-year institutions where 5-5 schedules are quite common.)

Attitudes among faculty, said Vedder – particularly at larger research institutions -- have hastened the transfer of teaching loads, in some cases, to graduate students and adjuncts. "Senior faculty can't be caught dead with undergraduate students," he said. "Moderately senior faculty members want to teach upper-level seminars and … teach graduate students."

But the reliance on adjuncts, noted many experts, is just an example of a larger philosophical shift that has occurred, both in society at large and in higher education. "Most would narrow it down to the concept of neoliberalism itself," said Adrianna Kezar, associate professor of higher education at the University of Southern California.

Typically, neoliberalism is defined as a philosophy that prizes the operation and ethos of the marketplace as a model for all human endeavors. Growing out of this philosophy is the conviction that private industry is inherently more effective, efficient and responsive than public entities. Applied to higher education, neoliberal approaches tend to prize the business function of the university and to seek to quantify often complex and interrelated activities (such as education) into data-driven metrics -- a process that critics fault as reductive and skewed.

Neoliberalism was also evident in many of the seven factors Kezar described as both causing and reflecting the diminished role of the faculty, including putting money into revenue-enhancing areas like fund-raising instead of instruction and treating students like customers. A fresh example playing out in Texas is the effort to quantify the efficiency and productivity of faculty.

Kezar also pinpointed the Bayh-Dole Act, which was enacted in 1980 and amended in 1984, as a key turning point. The law, which has been much lauded by research universities, among others, for revitalizing U.S. competitiveness, spawning new industries and situating universities at the center of economic development, gave institutions of higher education, small businesses and nonprofits control of the intellectual property of inventions that were funded by government research money.

But Kezar, who credited Rhoades and Sheila Slaughter, in their book *Academic Capitalism* (Hopkins), for the original insight, described one of the law's consequences: the weaving of higher education more seamlessly into the fabric of the market place. "The following 20 years have just been a continuation and an acceleration of that 1984 act toward where we are today," Kezar said.

At the same time, several scholars noted that bottom-line considerations, some of which point to conclusions that are unfavorable to professors, cannot be ignored, either. A large proportion of an institution's budget goes to personnel -- and the faculty comprises a significant share of those costs (though it is diminishing compared to administration).

And, as colleges feel more pressure to increase access to students, certain kinds of higher education cannot be offered in the same way they have been. It is simply not possible to do so on a wide scale, said Finkelstein of Seton Hall. "We can't have a model where a high-priced tenured professor teaches 20 students in a couple of courses," he said. "We have to do things differently."

Such a distribution of resources and, in a larger sense, the existence of a robust, tenured and institutionally powerful professoriate reflect a version of higher education that Finkelstein described as an historical aberration. The "golden age," as many referred to it, was the legacy of a huge influx of public money into higher education through the enactment of the GI Bill, which led many states to expand or add public institutions, and the establishment of the National Science Foundation, which helped give rise to the research university.

"We've had a 50-year run like nothing else," said Finkelstein. "We tend to think it's always been that way. It's never been that way. We've had all these great years and it's kind of a new historical moment."

But Rhoades of the AAUP countered this interpretation, saying that the "run" actually ended long ago. "The past has been past for 30 years," he said. "The condition we're in is not the result of the unsustainable halcyon days of the academy. The condition we're in is precisely the result of decisions."

Those decisions, said Rhoades, include prioritizing private gain over public investment -- for example, tax breaks for the wealthy over public education. In the context of higher education, he said, these decisions have resulted in a shift in the tuition burden from the state to the student, which has led to ever-increasing levels of student loan debt.

Another decision, made for what he described as short-term gain to the long-term detriment of both faculty and students, is the preponderance of adjuncts. "We've been at majority contingent faculty status at least since the early 1990s and it doesn't seem to be solving our problems," said Rhoades. "I would argue that this entrepreneurial model is what's unsustainable."

"It's not the new normal," he said. "It's old wine in a new bottle. We've seen the results of privatization and they're not great."

What's Next?

To newly minted Ph.D.s, the structural reasons for the lousy job market may well matter less than the inescapable fact that the job market is, well, lousy. Finkelstein said that the research he and Schuster have been doing "quite clearly suggests there isn't an academic career anymore."

While some observers thought that tenured faculty positions will remain a presence in the most elite colleges, nearly all agreed that the share of these jobs will continue to dwindle in most other areas of higher education. "Eventually, the last tenured professor will die," said Trower of Harvard. "We're not going to go back to the old days -- economically, technologically or politically."

For Vedder of Ohio, who has been teaching for 46 years, the darkening outlook has led him to change the advice he gives to his most promising students. "It used to be, until a few years ago, that I encouraged the best and brightest of my students. I urged them to consider following the career I followed," he said. "Nowadays, I've sort of gone in the reverse. I tell them you don't want to rule out a college career, but it's not what it used to be."

While others said they understand that logic, and they fault academe for producing too many doctorates when there is clearly not a big enough market within universities to absorb them, they still worry about the larger ripple effects of bright students turning away from careers in higher education in search of greater stability and a better shot at a middle-class life.

"The deterioration of talent will completely alter the academic profession," said Hermanowicz of Georgia, "and its impact will be likely felt not only on the intellectual fabric of society, but on the nation's scientific and economic infrastructure."

He and others hoped that faculty would be among those who looked more widely and strategically at what their universities' priorities should be. And, while some experts acknowledged that faculty members too often reflexively resisted change, others noted that the frequent turnover of administrators also made it difficult for faculty members and management to work together productively.

In particular, some observers suggested that faculty members ought to help prod their universities, especially large public ones, to be more judicious in their ambitions, even if it means taking a hard look at their own departments. In some cases, this may mean attending fewer conferences or being more hard-nosed about the need for every department to cover every specialty in every discipline.

"Is it better to have a smaller institution with exceptionally well-trained faculty who do what they do at a superior level," asked Hermanowicz, "or is it better to have a very, very large institution in which you have a tremendous mixture of talent and an extraordinarily heterogeneous faculty whose net outcome of work is really performed in a mediocre way?"

For Thelin of Kentucky, as worrying as all these trends are, one overriding characteristic of professorial life remains true, though with a caveat. "My take on being a professor is that it's still one of the all-time great jobs -- but it is becoming less so and less certain to be so."

— Dan Berrett

http://www.insidehighered.com/news/2011/05/16/life_for_college_professors_is_no_longer_what_it_once_was

Showing Up

May 27, 2011
By David Galef
That special day in May has arrived. The students in their graduation robes assemble by the administration building or the stadium or the largest parking lot on campus. They mill around, excited that they're about to leave the place where they spent the last four or more years, and anxious over the same state of affairs. A few administrators walk by in their regalia, the band or sound system starts up, and soon everyone will march.
So where are the faculty?
"Sorry," a veteran professor from the English department told me the day before, "but I never show up for these things." When I ask why not, he just shrugs. He's taught there for over 25 years. A few other professors respond similarly. The point is, they're not alone. I've taught at three different schools, and faculty attendance at commencement has always been dismal. This year, I was the only faculty member in my department to show up at graduation, and I find that -- let's be kind and say "puzzling." Why would you spend years helping your students and then refuse to attend the culmination of all that hard work?

Yet to ask that of most faculty seems to annoy them. They're independent-minded and don't like being told what to do, or even be questioned.
"Look, it's no secret that I'm not exactly a fan of the administration here," a colleague of mine tells me. "This is my way of flipping them off." He's not an evil guy, and this is his rationale for staying away from graduation, year after year.
"But you're mainly hurting the students," I reply. "When they're ready to graduate and none of the faculty show up, what do you think that says to them?"
He shrugs, and the conversation ends there.
Another non-attending teacher puts her hands on her hips when I ask her. "The students don't show up, so why should I?"
This observation is partly true, so I choose my words carefully. "How about for the students who *do* show up?"
Another shrug. That seems to be a popular response.
"Hey, I work for my students during the school year," a colleague from a previous school once told me. I didn't answer this point, mainly because I'd heard about his terrible teaching evaluations and recognized a self-serving argument when I heard one. "I'm too busy grading finals," a history professor from the same school told me.
"It's just too big," says another faculty member. "I might show up to see the students I taught, but I don't really feel a part of this..." he searches for the right word "...undertaking."
In fact, many institutions have both commencement exercises and individual school convocation ceremonies and departmental parties to see off their graduates. But attendance isn't great at those events, either, and anyway, that's still not a compelling reason for staying away from graduation.
At one institution where I taught, any faculty who didn't own their own gowns were obliged to pay for their own regalia, and that was the reigning reason for poor faculty attendance -- until the administration waived the fee, and faculty still stayed away.
At some schools, attendance at graduation is written into the faculty contracts. I gather this measure is necessary because otherwise, faculty representation would be pitiful. Why this should be so, I still can't fathom. I didn't enter this profession for big bucks or prestige -- if I had, I would've been misinformed -- but because I liked teaching and research. For all its pious platitudes, graduation still celebrates those aspects of academe.
It was many years ago, but I still recall the day I got my doctoral degree: an overcast afternoon that never quite rained. My department was, to put it charitably, ill-represented. My dissertation adviser arrived late and grumpy. I heard him telling another professor that the only reason he showed up was to hood someone -- "and I'm sorry I came because it looks like rain." At my undergraduate commencement, a few of the faculty from

my department came, but none stayed around afterward, though my father asked me to point out some of my teachers.
So I show up at graduation, part of a small cadre. “Hey, professor!” shout a couple of students who see me in my gown. I get a lot of handshakes and a few hugs. With a few, I discuss plans for after graduation, though a handful just want to chat. After the ceremony, some parents want to take pictures of the graduates alongside their professors, which is hard to do without faculty attending.
One student asks me point-blank, “Where are the other professors?” All I can do is shrug -- sympathetically.
When it’s over, I pack up and leave the school, still a little emotional, though I’m usually not that type. I’m proud for the students. I’m also upset at my colleagues.
Professors instruct in all sorts of ways. This method is called setting a bad example.
David Galef is an English professor and the creative writing program director at Montclair State University. He also writes dispatches from U of All People for Inside Higher Ed.

http://www.insidehighered.com/views/2011/05/27/galef_essay_on_why_faculty_don_t_show_up_for_graduation_but_should

Tablets, Yes; E-Texts, Maybe

May 25, 2011
While tablet computer ownership is still not prevalent among college students, a survey by the Pearson Foundation found that students say the devices could improve their educational experience -- and many say they want one. But the study also finds a disconnect between that demand and interest in digital textbooks.
About 8 in 10 college students surveyed said they believed that tablet computers were valuable for educational purposes, and most saw themselves owning a tablet in the future. Students who own tablets were even more likely to see an educational value in the devices, with 90 percent saying they thought tablets had value as educational tools.

While some of the report's findings bode well for tablets, they don't necessarily bode as well for digital textbook publishers, at least in the near term. The majority of students said they still prefer print editions to their digital counterparts. But with about 7 percent of students owning a tablet computer and 60 percent of college students saying they see one in their future, campuses could be seeing the first signs of the takeoff predicted last year.
"There seems to be this belief among students that tablets are going to fundamentally change the way they learn and the way they access what they are learning," said Adam Ray, director of communications and alliances for the Pearson Foundation. "Students see these devices as a way to personalize learning."
For the report, the foundation spoke with 1,214 college students between the ages of 18 and 30 who were enrolled in a two-year or four-year college or university, or graduate school, as well as 200 college-bound high school seniors. Ray said the study is the first of many that the Pearson Foundation will conduct on the topic of tablets. He said the foundation wants to track student perception of tablets as they become more widely adopted.
When Apple released the iPad in 2010, some administrators and faculty members said it heralded a new age of learning, since the devices could be used for multiple educational tasks such as reading textbooks and PDF documents, watching videos, and taking notes. Colleges tried various experiments with the device in its first year, with mixed results.
Adoption of the iPad and similar tablets, such as the Nook by Barnes and Noble and the Motorola Xoom, has been swift in the general population, but their use in the classroom has lagged. The study suggests that this may be changing, however; 15 percent of survey respondents said they intend to purchase a tablet in the next year.
Claims that tablets will revolutionize the learning experience often go hand-in-hand with a push for more digital textbooks, but the Pearson survey showed that students don't often link the two. While most students perceived an educational value to tablets, only 35 percent said they preferred digital editions to print editions, and only about half of those preferred tablets to other digital devices. Students said they were more likely to use the tablets for e-mail, managing assignments and schedules, and reading non-textbook materials such as study aids, reports, and articles.
The data suggest that the digital-textbook experience might actually be kind of a letdown. While 69 percent of students who said they wanted a tablet said they wanted to read digital textbooks on it, only 39 percent of students who owned tablets said they actually did.
"[Students] don't gravitate to the issues that we think of as really tangible, like the cost and ownership of a textbook," Ray said. "Instead they have these aspirational ideas of what an educational experience should entail. They have a certain amount of imagination."
A recent survey by Student Monitor found that demand for e-textbooks is not as great as envisioned, partly because textbook rental companies have helped to drive down textbook costs. In the same survey, only 5 percent of students said they purchased a digital textbook for the spring semester. Reports and surveys tend to distinguish between tablet computers, which have color monitors and touch screens, and e-readers such as the Amazon Kindle, which tend to use electronic paper technology.
There are some signs that administrators and policymakers are pushing ahead on digital textbooks anyway. Florida lawmakers passed a bill mandating that textbooks at all public elementary and secondary schools go

digital within five years. California State University announced on Tuesday a partnership with the Nature Publishing Group to produce interactive digital textbooks for college science courses. Next year, the students in introductory biology courses at the system's Los Angeles, Northridge, and Chico campuses will use a $49 digital version of the *Principles of Biology* textbook.
— Kevin Kiley

http://www.insidehighered.com/news/2011/05/25/students_see_educational_value_in_tablet_computers_but_not_digital_textbooks

Elaborating on Online Accessibility

May 27, 2011

The Department of Education on Thursday elaborated on a 2010 letter urging college and university presidents to make sure that the "emerging technology" on their campuses squares with federal laws protecting disabled students from discrimination.

While the original "Dear Colleague" letter focused on recent controversies over the accessibility of classroom devices such as electronic readers. Thursday's addendum made it clear that online courses and their content also must be accessible to disabled students -- even if none are currently enrolled.

"All school programs and activities -- whether in a 'brick and mortar,' online, or other 'virtual' context -- must be operated in a matter that complies with federal disability discrimination laws," said the addendum, which was written as an FAQ.

The Americans with Disabilities Act of 1990 and the 1973 Rehabilitation Act together prohibit public organizations, and those that accept federal funding, from excluding people with disabilities. This category includes nearly all colleges and universities, public and private, which are expected to accommodate disabled students either by making resources accessible via assistive technology, such as screen readers and entrance ramps, or by providing them with alternative services that do not leave them at a disadvantage.

Many colleges probably inferred that the original letter encompassed online learning, says Pratik Patel, chair of the information access committee at the American Council for the Blind. But that letter contained no mention of online programs, which for years have comprised the fastest-growing area of higher education. "I think it's wonderful that they did provide clarification for those colleges and universities that did not find it explicit," Patel said.

The accessibility of online courses -- and online components of classroom courses -- turns largely on the accessibility of online learning platforms and e-mail clients, which most online programs outsource to major software companies such as Blackboard, Pearson, Google, and Microsoft. According to a number of advocates, those large companies have been amenable to the needs of users with vision impairments and other disabilities.

However, digital learning technology is evolving rapidly, and approval from a given campus's disabled student services office is not always the first thing an instructor thinks about when introducing novel course content, says Kelly Hermann, chair of the Online Education Special Interest Group at the Association on Higher Education and Disability. Some advocates worry that as digital course content grows increasingly interactive and sophisticated, it will be more difficult to equip disabled students with assistive technologies capable of reading it, or supply them with an equivalent alternative.

In Thursday's release, the Education Department emphasized that compliance extends to part-time professors -- a population often utilized by online colleges, particularly in the for-profit sector, and one that includes a growing proportion of instructors on many campuses as well.

Adjuncts, who tend to receive less training and support than traditional faculty, are expected to furnish accessible course content and should be trained accordingly, the department said. "If an adjunct faculty member denies a student who is blind an equal opportunity to participate in a course by assigning inaccessible course content," it stated, "the school can be held legally responsible for the faculty member's actions."

Even courses and institutions that do not currently enroll disabled students are expected to take accessibility issues into account when introducing new technologies, the department says. "The planning should include identification of a means to provide immediate delivery of accessible devices or other technology necessary to ensure accessibility from the outset."

So far there have been no high-profile lawsuits over the accessibility of online learning programs, but the push-and-pull between campus technology and accessibility has not been without legal dust-ups. Two advocacy groups, the American Federation for the Blind and the American Council of the Blind, in 2009 sued to end pilot programs of an early version of the Kindle, Amazon's popular e-reader, at several institutions. The move prompted a debate over whether accessibility laws should apply to colleges that are merely test-driving new technologies, with some campus technologists arguing that such a standard could stifle innovation.

One section of Thursday's FAQ addresses that issue directly. "Does the ['Dear Colleague' letter] apply to pilot programs or other school programs that are short of duration?" the department asks, before answering: "Yes."

Martin Ringle, chief information officer at Reed College, which was one of the institutions named in the 2009 Kindle lawsuits, told *Inside Higher Ed* on Thursday that while he supports the document and accessibility in general, he remains skeptical that colleges should be beholden to federal accessibility laws during pilot programs. After all, he says, a college might not know whether a certain technology might have accessibility barriers until it tests it out.

"If you can't test it within the university without running afoul of the guidelines, you have to be able to turn somewhere for some kind of certification where someone is telling you which technologies are accessible and which ones aren't," Ringle said. He added that advocacy groups occasionally issue statements about certain products, but not for every new tool a college might want to try out.

Still, one prominent feature of Thursday's letter is its good faith, says Gregory Jackson, vice president for policy and analysis at Educause. The Education Department seems to recognize that these are thorny issues that colleges are not willfully ignoring, Jackson says. If the department were writing in response to abuses within a landscape of clearly defined rules and practices, he says, the letter would probably have been more strongly worded.

The National Federation for the Blind hailed the new guidelines in an e-mailed statement. "These documents give educational institutions ideas of how to practically apply their legal obligations when considering or deploying emerging technology, and in that respect they should be very valuable," wrote Chris Danielsen, a federation spokesman.

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

— Steve Kolowich

http://www.insidehighered.com/news/2011/05/27/education_department_elaborates_on_guidelines_against_discriminating_against_disabled_students_with_technology

Spit test offers guide to health

Telomeres may not predict how long we'll live, but they can still revolutionise medicine, says Nobel laureate Elizabeth Blackburn.
Jo Marchant


Elizabeth BlackburnTONI ALBIR/epa/Corbis

A test that claims to measure a person's "biological age" using the length of a person's telomeres — the DNA caps that protect the ends of our chromosomes — marketed by the Spanish company Life Length in Madrid, caused a media storm last week, inspiring wild headlines such as 'The £400 test that tells you how long you'll live'. But will testing the length of our telomeres soon be as routine as measuring cholesterol levels or blood pressure when it comes to assessing our health?

Intricately connected with ageing, telomeres shorten inexorably as cells divide, unless an enzyme called telomerase builds them back up again. As more studies link shortened telomeres with an increased risk of developing a daunting range of diseases — not to mention a reduced lifespan — perhaps it is not surprising that companies are lining up to offer commercial telomere tests.

Even the eminent Elizabeth Blackburn, who shared the 2009 Nobel Prize in Physiology or Medicine for her work on telomeres, is getting in on the act. She co-founded a company, Telome Health based in Menlo Park, California, which has developed its own test to measure telomere length in samples of saliva.

Blackburn spoke about the future of the field at a Berzelius Symposium on telomere biology in Stockholm, Sweden, this week. Nature asked her what she makes of the recent media claims, and what she believes telomere tests will do for medicine.

Can a telomere test predict how long you will live?

That's just silly, isn't it? It is statistical. Yes, there are mortality connections, but it's silly to say this will tell you your life length. You need to take it in context with other information.

So what can it tell you?

We and other groups are seeing clear statistical links between telomere shortness and risk for a variety of diseases that are becoming very common, such as cardiovascular disease, diabetes and certain cancers. We have also looked at chronic psychological stress, including depression and post-traumatic stress disorder, and more and more we see associations with telomere shortness. There are even links with education — in one study telomere shortness was related to not finishing school.

The emerging science is looking at changes in telomere length over time. We're seeing the data unfolding in front of us. A lot of them are not published yet, but in one study, we looked at ageing adults[1]. Those whose telomere length fell over a 2.5-year period were three times more likely to die from heart disease over the subsequent nine years than those whose telomere length went up or was maintained.

How can telomere tests be useful in medicine?

You get a statistical association with risks for common diseases. In the past, most of the big medical problems have been specific, drastic things — infectious diseases, broken legs — that you had to fix. Medicine has been successful by treating diseases in a very specific way once the damage is done. But telomere length integrates a lot of factors together and gives you an overall picture of risk for what is now emerging as a lot of diseases that tend to occur together, such as diabetes and heart disease. That is not a familiar model to the medical world.

Interventions might include doing things that allow people to cope with their stress, for example, and encouraging exercise, which emerging studies show is associated with telomere maintenance.

But we already know that if we exercise and reduce stress, we will have lower disease risk.

This gives a form to it. It is seen as a bit 'loosey goosey' to talk about lifestyle and things like that. This gives a very concrete — albeit statistical — readout of how you are doing. We have a study going on now and people were beating down the doors to be in it. So this seems to be a useful measure that people can relate to. Having something where you can see changes may be particularly useful. For example, if you exercise, perhaps this could give you a physiological biomarker for how you are doing.

Apart from prescribing a healthy lifestyle, how might a doctor use this information?

I'll give you an example: a very interesting study in which researchers looked at Scottish men who had one or more risk factors for cardiovascular disease[2]. They looked at telomere length, then gave statins [which lower the risk of heart disease] or placebo and asked, how protective in the subsequent years was the statin? Well, it made no difference to people whose telomere length was in the top third — it was essentially wasted on a third of the people. We are also finding interesting relationships between telomerase activity and whether people respond to antidepressant medication.

Your test measures telomere length in white blood cells, why?

For convenience — those are the cells in saliva. Telomere length is not the same for every cell type, but someone who is short for one category generally is shorter for the others. However, there is also very good disease relevance for using white blood cells. It turns out that the status of your immune system is probably quite related to the diseases we are talking about. For example, heart disease is associated with activation of the inflammatory branch of the immune system. It's the body's basic response to wounds and infection but if it's switched on long-term, for example by stress, it can be very damaging to the body's tissues and is associated with chronic diseases like heart disease.

So telomere length could be more than just a biomarker?

The conservative statement is that telomere length is a biomarker, but it's probably not passive. There are some very intimate relationships between things such as molecular markers for inflammation and telomere health. We've just published a big analysis that relates a couple of inflammatory markers, interleukin-6 and tumour necrosis factor-α, to telomere shortness[3]. Those in turn have been related to high levels of inflammation and cardiovascular disease.

Could we develop drugs to protect or lengthen our telomeres?

My colleagues and I are not interested in making drugs at this point, although I'm sure people will want to do this. Everyone wants a magic pill, but it's a long road to develop any kind of pill. It's not a stupid idea, but let's be realistic about how long it'll take.

What are the next questions for research?

Telomere length has an interesting statistical predictive value, so the question for future research is what's the biology, what's going on? How do we tease out the different components of effects — which are genetic and which are non-genetic; which are causal and which are related? Challenges in medicine are moving from 'treat the symptoms after the house is on fire' to 'can we preserve the house intact?' Can we use what we learn about disease processes to think about prevention and earlier interception?

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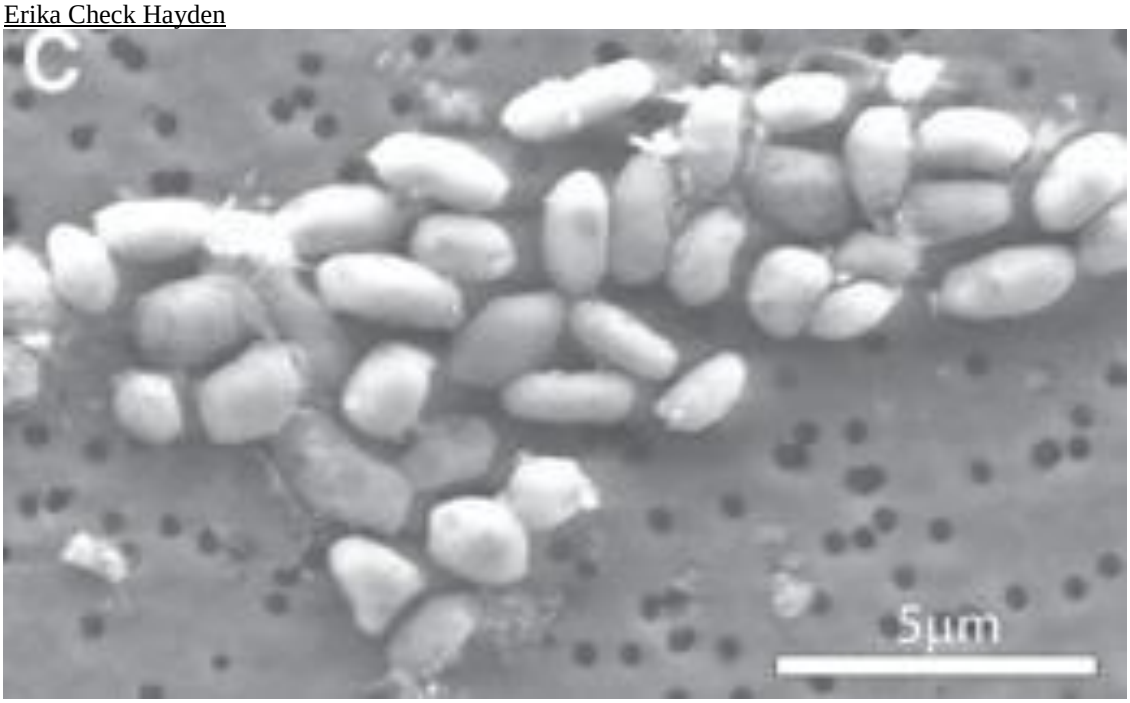
Critics weigh in on arsenic life

Field needs independent experiments to prove or disprove the work, researchers say.
Erika Check Hayden



Scanning electron micrograph of bacteria strain GFAJ-1.Science/AAAS

Nearly six months after its online publication in Science[1], the controversial suggestion that a newly discovered bacterium survives by incorporating arsenic atoms into its DNA and other biomolecules is facing a volley of terse critiques which appeared today on the journal's web site.

Many of the criticisms had already been aired through blogs and other publications. The arsenic paper's authors, who had previously defended their work, continue to do so in a technical response issued today alongside the critiques. They say they will distribute samples of the bacterium, GFAJ-1, so that other researchers can attempt to replicate their work.

Now the field is looking to independent researchers to take them up on that offer, to support - or refute - an overwhelming sense that the study suffers from flaws that undermine its conclusions. Some were frustrated that the authors did not release any new data in their response, noting that most of the critiques released today were submitted just days after the original paper was published, and had been aired publicly, allowing ample time for the authors to bolster their case with new data.

"I'm tired of rehashing these preliminary data," said John Helmann of Cornell University in Ithaca, New York, who critiqued the work in January on the Faculty of 1000 web site. "I look forward to the time when they or others in the field start doing the sort of rigorous experiments that need to be done to test this hypothesis."

The controversy first erupted in December, when NASA's press office issued a cryptic news release regarding an "astrobiology finding that will impact the search for evidence of extraterrestrial life." Once revealed, it quickly became apparent that the finding, if true, would be astonishing, because it would imply that an organism has evolved to incorporate the usually toxic element into its genetic backbone, possibly suggesting a broader range of molecular building blocks for life on Earth and beyond.

However, the work was quickly assailed by researchers, both for not living up to NASA's billing about relevance to extraterrestrial life, and for being marred by technical shortcomings that, they said, imperil its eye-popping conclusions.

"I have not found anybody outside of that laboratory who supports the work," says Barry Rosen of Florida International University in Miami, who published a critique of the work in BioEssays in March.

A dearth of believers

The comments published today include eight critiques of the original paper, whose first author was Felisa Wolfe-Simon of the NASA Astrobiology Institute and the U.S. Geological Survey in Menlo Park, Calif. Wolfe-Simon has previously defended her work both on her web site, and in the pages of the women's magazine Glamour , where she dispensed her "four laws of getting people to believe in you."
"We maintain that our interpretation of As [arsenic] substitution, based on multiple congruent lines of evidence, is viable," she and her colleagues write today.

Felisa Wolfe-Simon is collects a sample from 10 Mile Beach at Mono Lake,California.© 2010 Henry Bortman

In their study, the authors analyzed bacteria taken from Mono Lake in southern California. The bacteria were grown in the lab on a medium that, the authors said, contained arsenic but no phosphorus - the core constituent of the DNA double helix. The authors found that the bacteria reproduced, and integrated arsenic into their DNA.
The critiques attack multiple parts of the work. Several allege that the growth medium that supposedly only contained arsenic actually contained trace amounts of phosphorus - enough to support a few rounds of bacterial growth. Others say that the evidence purporting to show that arsenic integrated into the bacterium's DNA is flawed because the DNA was not properly purified.
Two authors in Hungary write[2] that the authors used flawed methods to calculate the ratios of arsenic and phosphorus in their growth media. Many of the authors also said that there are alternative explanations for the fact that the bacteria could grow on a medium containing little or no phosphorus, such as the possibility that the medium selected for arsenic-tolerant bacteria that out-competed the non-tolerant microbes.
Some criticisms of the work come from within the same agencies that employ the authors; four of the authors of one critique are based at NASA's Jet Propulsion Laboratory, managed by the California Institute of Technology in Pasadena, Calif.
"GFAJ-1 appears to do all it can to harvest P atoms from the medium while drowning in As," they write[3]. "This suggests that GFAJ-1 is an extraordinary extremophile but does not support the more exceptional claim that As replaces the functions of P in this organism."

In search of follow-up

Steven Benner of the The Foundation for Applied Molecular Evolution in Gainesville, Fl., suggests a series of follow-up experiments that could be done to provide more solid evidence that arsenic has incorporated into the bacterium's DNA[4]. The big question for the field is whether and when independent labs will perform the necessary follow-up experiments to provide evidence that would support or rebut the critics' claims.
If GFAJ-1 is indeed utilizing arsenic as Wolfe-Simon and her coauthors suggest, Benner writes, the result would "set aside nearly a century of chemical data concerning arsenate and phosphate molecules." Benner cautions that inconsistent results should not be "discarded out of hand", however he criticizes the paper for not fully taking into account how much existing science would need to be rewritten to accommodate its extraordinary claim.
Rosemary Redfield of the University of British Columbia, who previously critiqued the arsenic paper on her blog and who published one of the commentaries released in Science today[5], says that proving or disproving the work would not be difficult. She said it would be "relatively straightforward" to grow the bacteria in arsenic-containing media and analyze it using mass spectrometry to test whether arsenic is covalently bonded into the DNA backbone.
"The important thing to do is what the authors didn't do, which is meticulously clean up the DNA first," Redfield said.
She said that she would likely obtain samples of GFAJ-1 and is considering performing the follow-up experiments she describes, and is especially interested in getting a group of five of six laboratories to repeat the experiments independently and publish their results together.
However, most labs are too busy with their own work to spend time replicating work that they feel is fundamentally flawed, and it's not likely to be published in high-impact journals. So principal investigators are reluctant to spend their resources, and their students' time, replicating the work.

"If you extended the results to show there is no detectable arsenic, where could you publish that?" said Simon Silver of the University of Illinois at Chicago, who critiqued the work in FEMS Microbiology Letters in January and on 24 May at the annual meeting of the American Society for Microbiology in New Orleans.
"How could the young person who was asked to do that work ever get a job?" Silver said.
Refuting another scientist's work also takes time that scientists could be spending on their own research. For instance, Helmann says he is in the process of installing a highly sensitive mass spectrometry machine capable of measuring very small amounts of elements. But, he says, "I've got my own science to do."
Helmann also points out that the bacterium is not yet available through cell repositories, and that researchers may be reluctant to sign the materials transfer agreement required to obtain it from the authors.
He and other researchers also said that the response released by the authors of the Science paper appear reluctant to accept that there may be alternative explanations for the phenomenon they observed.
"With so many mistakes pointed out, there should be at least some where the authors say, you're right, we should have done that but we didn't," Redfield says. "This as an entirely a 'we were right' response, and that's a bad sign in science."
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German E. coli outbreak leads to drug trial

Timely discovery of new use for expensive drug put to the test.
Marian Turner

The outbreak has been blamed on contaminated fruit and vegetables.Joern Pollex/Getty

Germany's battle with what now rates as Germany's worst ever outbreak of enterohaemorrhagic Escherichia coli infection hit a new level today with the announcement of a record number of patients suffering life-threatening complications.

Attempting to forestall anticipated deaths, doctors in the north German cities in which the outbreak is centred have set up a spontaneous clinical trial for an experimental antibody drug called eculizumab (Soliris; Alexion), recently listed by Forbes as the world's most expensive.

Adding up

The bacterial infection, known as EHEC, has already claimed at least two lives and infected around 800 people. Almost 300 of those have developed haemolytic uraemic syndrome (HUS), which can cause kidney failure, neurological complications and death.

Infections with EHEC bacteria — which are endemic in cattle but cause diarrhoeal disease in humans — occur intermittently, mostly in children, and are rarely fatal. But most of those affected so far by this outbreak have been young, adult women who were perfectly healthy a week earlier, a demographic that is baffling epidemiologists (see 'Critical hours for E. coli outbreak in Germany').

EHEC cases have now been seen in Denmark, Sweden, the Netherlands and the United Kingdom — mostly in people who have recently been to northern Germany. According to the Berlin-based Robert Koch Institute, the national institute responsible for disease control, the number of HUS cases jumped from 214 on Wednesday to 294 on Friday. Usually only around 60 patients are seen with HUS per year in Germany.

Rolf Stahl, head of the nephrology clinic at the Hamburg-Eppendorf University Hospital, and Reinhard Brunkhorst, president of the German Society of Nephrology, are today rolling out an emergency eculizumab treatment strategy to hospitals across the country.

The drug is currently used to treat a rare disorder of the immune system called paroxysmal nocturnal haemoglobinuria, and a year's treatment costs more than US$400,000. But just this week a study published in the New England Journal of Medicine reported successful use of the drug in treating three patients with HUS[1]. The drug's manufacturer, Alexion, is now providing eculizumab free of charge in Germany, taking advantage of an unexpectedly large cohort of patients that might help to speed the drug's approval for the treatment of HUS.

Magic bullet

Eculizumab targets a member of the immune system's complement pathway called complement 5. Complement proteins are activated by the Shiga toxin produced by EHEC and are an important component of the immune response to infections. But overactivity of complement proteins, which scientists think occurs in HUS, can lead to tissue damage, particularly in the kidneys. "By blocking complement using eculizumab, we saw a dramatic improvement in the patients' blood-cell counts and kidney function," says Michael Kirschfink at the University of Heidelberg, a co-author on the New England Journal of Medicine paper[1].

Brunkhorst and his team at Hanover Medical School are already treating eight patients with eculizumab, and other hospitals are expected to rapidly follow suit. "But we don't want to be overly optimistic," he cautions "we have very little experience with this drug and don't know how effective it will be."

The doctors are also learning on the run. They don't know whether to give the drug during the early stages of renal failure, or only once neurological symptoms set in.

On Wednesday, scientists in Helge Karch's laboratory at the Münster University Hospital confirmed that the current outbreak is caused by a rare strain of E. coli called O104:H4. This strain has never previously been implicated in an outbreak of human EHEC infections. And so while doctors are racing to save patients' lives, scientists are racing to sequence the strain's DNA and understand the biology behind the infection's severity and rapid spread.

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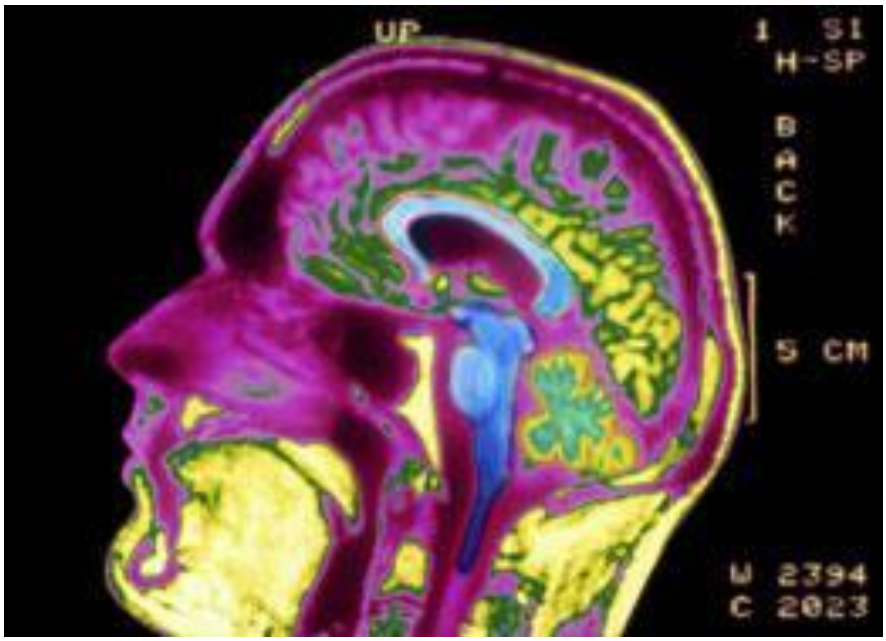
Neuroscientists unite for 'Moon shot'

Effort aims to bring together philanthropies with common interest in brain diseases.
Heidi Ledford



Moves are afoot to reduce the focus on disease-specific research in favour of more fundamental work.Glowimages

Fifty years after US President John F. Kennedy pledged to send a man to the Moon, his nephew Patrick has brought together leading lights of neuroscience to tackle the "inner space" of the human brain.

At a meeting in Boston, Massachusetts, this week, the former Democratic congressman from Rhode Island helped to launch an initiative called 'One Mind for Research', which aims to boost support for neuroscience. Kennedy and his collaborators hope to convince funders to relax their focus on individual diseases in favour of supporting basic research on the fundamental workings of the brain.

The effort comes at a crucial juncture for the field. Even as technological advances in imaging techniques and stem-cell-derived disease models hold out the tantalizing possibility of new advances, neuroscientists, like other biomedical researchers, face the threat of cuts to federal research funding.

Meanwhile, researchers have watched as one pharmaceutical company after another has stopped research on diseases that affect the central nervous system. "They are exiting brain sciences as 'too difficult', just at a time when we're about to make it easier for them," said Steven Hyman, provost of Harvard University in Cambridge, Massachusetts, at the conference on Monday.

How One Mind for Research will change this landscape, however, remains unclear. Kennedy and his collaborators have enlisted the support of top academic and political players, including US Vice President Joe Biden, who delivered a keynote address yesterday. But some researchers expressed unease at the idea of blending their research goals with political rhetoric. And thus far the programme is long on lofty goals and short on specifics.

"The key question is, what's next?" says Thomas Insel, director of the National Institute of Mental Health in Bethesda, Maryland. "What's the agenda?"

Personal connections

One Mind for Research has its roots in a charity now called the International Mental Health Research Organization (IMHRO), which has been holding music festivals to fund research into neuropsychiatric diseases since 1995. The charity,founded by Shari and Garen Staglin after they learned that their son had schizophrenia, is part of a fragmented community of advocates for neuropsychiatric disease research. Insel estimates that there are about 50 disease-specific advocacy groups that lobby his institute for funding.

Over time, the Staglins realized that this fragmentary system was inefficient.

Disparate brain disorders sometimes share features, such as inflammation, meaning that a disease-specific focus could lead to duplication of effort. Nevertheless, uniting the charities under one umbrella is difficult, says Shari Staglin, because each organization wants to maintain its own stable of prized donors, and those donors — many motivated by personal tragedies — often want their funds to go to understanding the specific disease that has affected their lives.

But those barriers began to fall when the Staglins joined forces with Kennedy and enlisted the support of celebrities including actress Glenn Close and actor Martin Sheen. Kennedy, who has himself struggled with depression and substance abuse, has long had an interest in mental health and has worked to boost the coverage of mental-health therapies by medical insurance companies.

On message

At the meeting on Tuesday, Garen Staglin outlined a few of the programme's early ambitions to develop research tools, including a registry of patient records and tissue samples. Staglin says he hopes to build a repository of up to one million samples and, eventually, full genome sequences to accompany each.

Another goal is to launch an aggressive fund-raising campaign. The meeting emphasized issues that resonate with the public, such as the plight of US soldiers in Iraq and Afghanistan who have faced high rates of post-traumatic stress disorder and traumatic brain injuries. "These 'wounded warriors' provide an opportunity to highlight the struggle faced by everyone who suffers from mental illness," says Kennedy. "The American people are paying attention to the fact that these soldiers are falling through the cracks."

In July, the initiative will hold a meeting of business leaders in the health-care industry. The hope, says Husseini Manji, global head of neuroscience research and development at Johnson & Johnson Pharmaceuticals, headquartered in New Brunswick, New Jersey, is to get the attendees to commit to contributing resources — either cash or technical expertise — for developing collaborative projects that could spur the early stages of drug research.

The details of that collaboration are still fuzzy, but Manji, who is heading up the effort, says it may include finding new uses for existing drugs. Manji envisions an agreement modelled on the Alzheimer's Disease Neuroimaging Initiative, a public–private partnership that forgoes intellectual property rights on its discoveries in favor of rapidly depositing results in public databases.

But that model will not be enough, he cautions, and he hopes to create an additional One Mind programme that would allow companies to retain patent rights. "If you don't do that, companies will just dump their rejected compounds into the pile," he says. "And we want researchers to get access to industry's best leads."

Manji has already presented his goals to several industry groups. He admits that there are signs of 'consortium fatigue', but says that One Mind's high-profile backers have nevertheless attracted interest.

Meanwhile, Insel is cautiously optimistic about the programme. "I don't know where this is going, but it is a great concept," he says. "Funding for the National Institutes of Health is not going up at this point, so we've got to start thinking about what else we can do.

http://www.nature.com/news/2011/110526/full/news.2011.324.html

Hawaiian hot spot fuels volcano debate

Textbook picture of Earth beneath Hawaii may be wrong.
Nadia Drake

How Hawaii's volcanoes formed has long been the subject of debate.Frans Lanting/Corbis

The plumbing of Hawaii's volcanoes might not be as straightforward as scientists thought. Rather than being fuelled by a vertical plume of magma rising from deep within the Earth, a new study suggests that volcanic activity in the region is fed by a massive hot pool of rock lurking in Earth's mantle some 1,000 kilometres to the west of the islands.

"The simple, canonical textbook picture of Hawaii is probably wrong," says Robert van der Hilst, a seismologist at the Massachusetts Institute of Technology in Cambridge and a co-author of the volcano study, published today in Science[1].

For decades, scientists have puzzled over the origin of Hawaii and its volcanoes, which are located in the middle of a tectonic plate and not at the seams, where such volcanism is expected. Diagrams of the islands' formation, based on the mantle plume theory developed in 1971 by US geophysicist Jason Morgan[2], depict Earth's crust and tectonic plates sliding above a deep, stationary, bottle-shaped plume of molten rock. Upwellings of lava from the plume build huge volcanoes on the ocean floor that eventually become islands. Over time, the moving plate extinguishes the volcanoes, and the older volcanic islands erode and sink beneath the Pacific — leaving behind the Hawaiian–Emperor seamount chain, which stretches as far north as the Aleutian Trench.

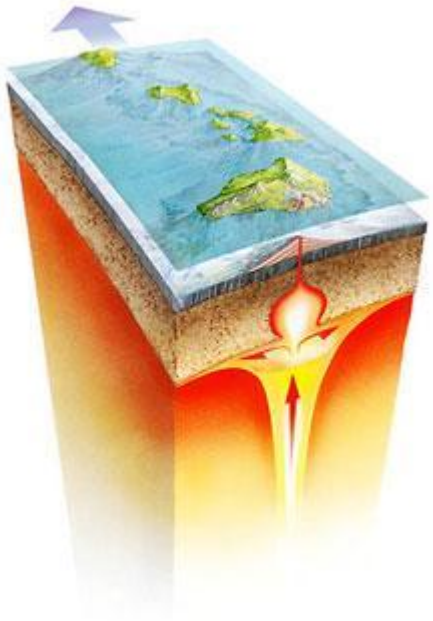
Now, van der Hilst and his team suggest that Hawaii's volcanic plumbing might be considerably different: they think that the islands draw their fire from a huge hot pool of material as much as 2,000 kilometres wide, festering nearly 700 kilometres beneath Earth's surface.

"Hot materials seem to be trapped near the top of the lower mantle," says first author Qin Cao, a graduate student with van der Hilst. "There might be secondary plumes stemming from this hot pool and fuelling current volcanism."

Plumbing the depths

But peeling back Earth's crust wouldn't reveal a massive, glowing lake of magma. Instead, pressures that far down are so high that the mantle is solid and rocky. The rocks are squeezed to the point that minerals abruptly

reorganize themselves, forming 'discontinuities', which act as mirrors for seismic waves. Seismic signals reflect off these discontinuities and can pinpoint deep subterranean structures such as plumes. Mapping the depths at which seismic waves are reflected can provide temperature readings of Earth's interior.



This classic diagram of the plume beneath Hawaii may not be correct.GARY HINCKS/SCIENCE PHOTO LIBRARY

Cao, van der Hilst and their colleagues used such subsurface features to identify the massive hot spot. They gathered seismic data from some 4,800 earthquakes recorded at stations around the Pacific Ocean, and included nearly 170,000 reflected seismic waveforms in their analysis, which incorporated a technique commonly used in oil and gas exploration. Next they applied mineral-physics models of how different minerals behave at different pressures and temperatures to predict the temperature at the subsurface regions that reflected seismic waves, and inferred the existence of a huge, hot region west of the islands.

"Our results suggest a new picture of the internal dynamics of our planet," Cao says, adding that there are implications for the recycling of materials within the Earth, planetary heat transfer and formation, and geochemistry.

"This is a really clever way of processing the data," says seismologist Arwen Deuss at the University of Cambridge, UK. Confirming the results using different methods is the next step, she adds, with the caveat that working on subterranean structures in the deep ocean is complicated by the lack of local sensors.

Subterranean signals

But seismologist Edward Garnero, of Arizona State University in Tempe, points to inconsistencies in the strengths and patterns of the team's seismic reflections, which differ from the results of other studies in the area[3]. And Thorne Lay, a seismologist at the University of California at Santa Cruz, worries that the authors did not select data that were clean enough for their analysis, and that noisy signals may introduce errors. "Careful data selection leads to robust models," Lay says. "There aren't 170,000 good-quality waveforms."

Van der Hilst argues that the same technique applied to a nearby region produces the same patterns in the mineral layers, and that using carefully chosen data might bias results. "There is no doubt that we include data that seismologists looking at individual traces would find too noisy," he says. "But we can exploit the noise reduction of very large data sets."

Seismologist Cecily Wolfe, of the University of Hawaii in Honolulu, has also studied the Hawaiian hot spot by deploying an array of ocean-bottom seismometers around the islands[4,5]. Using a different technique, she and her team imaged something resembling a plume beneath the islands that extended into the uppermost part of the lower mantle.

"This is an interesting and worthwhile study," Wolfe says. "But the results are puzzling. I think there are still questions with both of our results. It is nice when you have multiple people doing multiple analyses that lead to a consensus — but we haven't reached that point yet."

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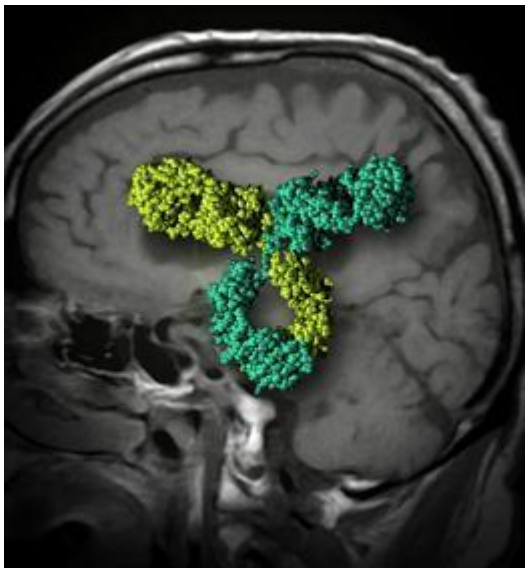
http://www.nature.com/news/2011/110526/full/news.2011.327.html

Engineered antibodies cross blood–brain barrier

Technique could be used to design therapies for Alzheimer's and other diseases.
Heidi Ledford



Antibodies that bind to more than one target can get past the blood–brain barrier.Genentech

By defying the classical rules of antibody engineering, researchers have constructed an antibody that is readily shuttled into the brain. The results suggest that the approach could be used to generate antibody-based therapies for brain diseases.

Antibodies — proteins used by the immune system to neutralize damaging foreign substances — are prized both in nature and in the laboratory because they are highly specific. But researchers in academia and industry are increasingly striving to make antibodies that bind to more than one target.

"We're about to see a wave of bispecific antibodies," says Ryan Watts, a neurobiologist at Genentech, a biotechnology firm based in San Francisco, California, that pioneered the development of therapeutic antibodies and is now a division of the Swiss pharmaceutical giant, Roche. "They are the hot topic in the field."

But few of those antibodies will be able to penetrate the shield of tightly packed cells known as the blood–brain barrier, which protects the brain from blood-borne intruders such as bacteria, but also keeps out most large drug molecules. Antibody concentrations in the brain are typically about a thousand times lower than in the blood, says Watts.

In two papers published today in Science Translational Medicine[1,2], Watts and his collaborators report the design of an antibody that surmounts this obstacle.

The antibody targets two proteins. The first, called β-secretase 1, is a popular target for drugs to treat Alzheimer's disease, because it has an important role in the production of amyloid peptides in the brain. According to the 'amyloid hypothesis', amyloid aggregates are responsible for the hallmark brain damage and memory loss of the condition.

The second protein targeted by the antibody is the transferrin receptor, which activates a molecular channel that normally imports iron into the brain. By clinging to this receptor, the antibody is transported into the brain, where it can act against β-secretase 1.

The double-duty antibody performed well in mouse models of Alzheimer's disease: a day after receiving a single injection of the antibody, concentrations of amyloid-β in the brain plummeted by 47%[1].

But before the Genentech team could achieve those results, they had to defy another cardinal rule of antibody engineering.

Letting go

The strength of the interaction between an antibody and its target is called its affinity: the higher the affinity, the stronger the interaction. Most antibody engineers strive to make antibodies with the highest affinity and tightest binding possible.

Watts and Mark Dennis, an antibody engineer at Genentech, started out making antibodies with high affinity against the transferrin receptor, but found that they stayed locked within the blood vessels of the brain rather than penetrating its tissues. Dennis reasoned that the receptor could be the trapping the antibody in the vasculature, so he engineered an antibody with lower affinity for it.

As he had predicted, the lower-affinity antibody was distributed more broadly in the brain[2]. Watts and Dennis liken the transportation of molecules by the receptor to a ski lift. "The high-affinity antibodies never get off the ski lift," says Watts. "The low-affinity antibodies get off and are widely distributed."

"It's a nice demonstration of how, when you look at multispecific protein therapeutics, you have to throw out some of the rules and paradigms that we learned through monoclonal antibodies," says David Hilbert, head of research at Zyngenia in Rockville, Maryland. His company is developing multispecific antibodies that have been modified to recognize as many as five different targets.

Hilbert notes that low-affinity, multispecific antibody designs might also be useful in other arenas. Cancer stem cells, for example, are often identified on the basis of a combination of marker proteins that they express on their surfaces. But these markers are sometimes present in other combinations on healthy cells. A traditional high-affinity monoclonal antibody could kill those healthy cells as well as their cancer targets, but a low-affinity, multi-targeted antibody could more selectively target the cancer stem cells, says Hilbert.

"Such a drug would tumble through the host transiently binding cells that express only one or two of the targets," says Hilbert. "But when the drug encounters a cancer stem cell, it will engage all targets, thereby turning multiple low-affinity interactions into a net high-affinity interaction."

Competitive edge

Not everyone is a fan of the low-affinity approach, however. "From a technical standpoint, it's beautiful work," says William Pardridge, an endocrinologist at the University of California, Los Angeles, who has long studied the blood–brain barrier. "But conceptually, I think they've gone down a blind alley."

Pardridge is the founder of a competing company, ArmaGen in Santa Monica, California. He says that his lab and the scientists at ArmaGen have dispersed their antibodies throughout the brain using the same receptor, without having to reduce affinity. He adds that Genentech's design has left the company with an antibody that must be given at unreasonably high doses. "I hope it goes down this path," Pardrige says. "Then I'll have one less competitor."

Watts counters that the doses used in Genentech's mouse study are normal. He says that it is common for therapeutic doses of antibodies to be higher in mouse models than in humans, where the antibodies tend to remain active for longer before being broken down by the body. Genentech intends to move forward with the platform, says Watts. "This was a critical proof-of-concept. We're looking at applying it to other targets in the central nervous system."

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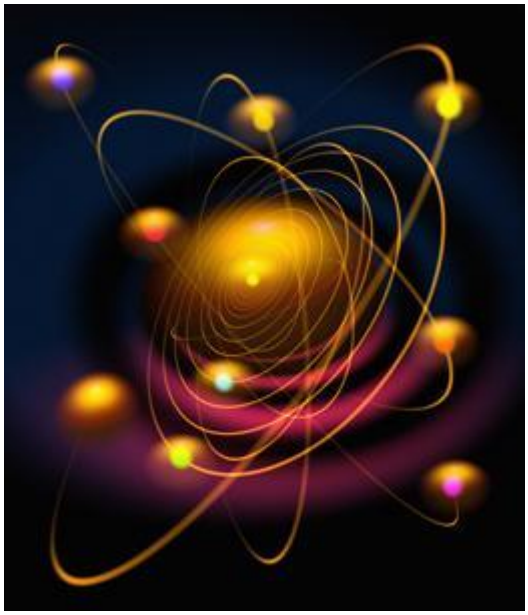
http://www.nature.com/news/2011/110525/full/news.2011.319.html

Rounding the electron

Physicists step up the search for particle's predicted deformity — and hope to solve antimatter mystery along the way.

Edwin Cartlidge



The electron might be ever-so-slightly squashed.MEHAU KULYK/SCIENCE PHOTO LIBRARY

Now that's precision measurement: the electron is a perfect sphere, give or take barely one part in a million billion.

The result comes from the latest in a long line of experiments to probe the shape of the fundamental particle that carries electrical charge. "If you imagine blowing up the electron so that it is the size of the Solar System, then it is spherical to within the width of a human hair," says physicist Edward Hinds at Imperial College London, who led the team responsible for the minuscule measurement.

But this is more than a quest for accuracy. Many physicists are intent on finding out whether the electron is actually slightly squashed, as some theories predict. If the deformity is there, further refinement of the technique that made the latest measurement should pin down the deformity in the coming decade. The discovery would show that time is fundamentally asymmetrical, and could prompt an overhaul of the 'standard model' of particle physics.

Although the electron has traditionally been considered to be an infinitesimally small point of charge, it actually drags a cloud of virtual particles around. These fleeting particles pop in and out of existence, and contribute to the electron's mass and volume. All experiments so far have revealed that this cloud is perfectly spherical, but hypothetical virtual particles predicted by extensions to the standard model would make the cloud bulge slightly along the electron's axis of spin. This bulge would make one side of the electron slightly more negatively charged than the other, creating an electric dipole similar to the north and south poles of a bar magnet.

Physicists argue that we would expect to see this electric dipole in a Universe which consists overwhelmingly of matter. Although equal quantities of matter and antimatter are thought to have been created in the Big Bang, we see almost no antimatter in today's Universe. This asymmetry not only implies a cosmic favouritism for matter, but also suggests that physics does not always work the same way when time is run backwards instead of forwards.

Be kind, rewind

Evidence of this asymmetry could be found by playing a film of a spinning, slightly squashed electron in reverse. Although the direction of the electric dipole would remain unchanged, the magnetic dipole around the electron — which depends on the direction of its spin — would flip to the opposite direction.

The latest study, published today in Nature[1], looked for the effect of this asymmetry on the spins of electrons exposed to strong electric and magnetic fields — but found nothing. Indeed, the researchers say that any deviations from perfect roundness within electrons must measure less than a billionth of a billionth of a billionth of a centimetre across.

“If you imagine blowing up the electron so that it is the size of the Solar System, then it is spherical to within the width of a human hair.”

Edward Hinds

Imperial College London

Similar measurements had previously used beams of atoms passing through magnetic and electric fields. But Hinds and colleagues instead used molecules, which can be more sensitive to the fields. Using a pulsed beam of ytterbium fluoride, they were able to improve on the previous best sensitivity — achieved in 2002 by Eugene Commins and colleagues at the University of California, Berkeley, who used thallium atoms[2] — by a factor of about 1.5.

Getting better all the time

Hinds reckons that by increasing the number of molecules per pulse and reducing their speed, his group should be able to raise the sensitivity of measurement by a factor of ten "over the next few years", and, ultimately, by a factor of 100. This would be more than enough to detect the distorting effects of most modifications to the standard model, and would thus provide evidence for the existence of new, very massive particles. A non-discovery, by contrast, would send theorists back to the drawing board.

"We would pretty much rule out all current theories if we went down by a factor of 100 and saw nothing," he says. "But theorists are very creative and would probably come up with models where the electric dipole moment is smaller."

Commins agrees that the latest work opens the door to major discoveries. "In the half-century since such experiments began, this is the first time that the best upper limit on the electric dipole has been achieved using molecules," he says. "Since molecules offer much greater sensitivities than atoms, it is only a question of time before the limit is greatly improved."

David DeMille of Yale University in New Haven, Connecticut, who was a co-author on the 2002 paper[2] with Commins and is carrying out molecular experiments of his own using thorium monoxide, agrees. "On the face of it, the actual improvement in precision in the latest work is rather small," he says. "However, this paper represents the first of what many in the field believe to be a coming wave of potentially much larger improvements, because of new experimental methods that are being developed."

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http://www.nature.com/news/2011/110525/full/news.2011.321.html

Vaccines: The real issues in vaccine safety

Hysteria about false vaccine risks often overshadows the challenges of detecting the real ones.
Roberta Kwok

John Salamone is not a vaccine sceptic. He has never been persuaded by spurious claims that vaccines are toxic to children and responsible for autism or a host of other ailments. But tragically, Salamone found out first-hand that vaccines do have real, rare side effects when he saw his infant son, David, become weak and unable to crawl shortly after receiving the oral polio vaccine in 1990. After about two years of physical therapy and doctors' visits, Salamone learned that owing to a weakened immune system, David had contracted polio from the vaccine. "We basically gave him polio that day," says Salamone, who has retired from a position as a non-profit executive, and lives in Mount Holly, Virginia.

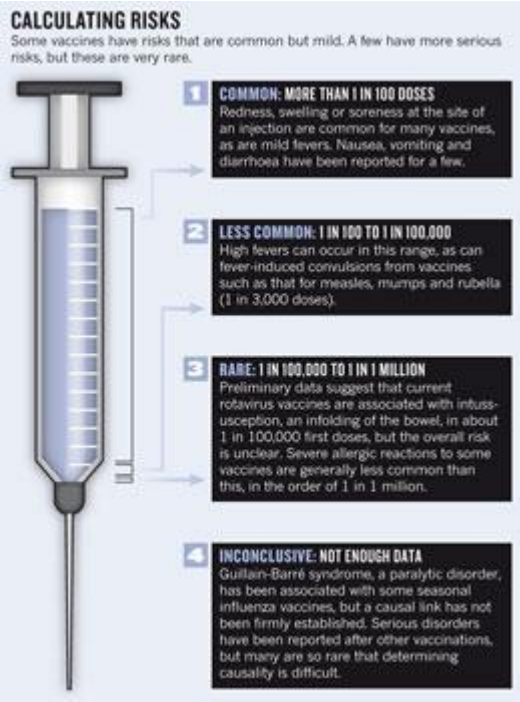
That was a known risk of the vaccination, which causes roughly one case of the disease per 2.4 million doses, often in people with an immune deficiency. A safer, inactivated, polio vaccine was available at the time, but the oral vaccine was cheaper, easier to administer and thought to be more effective at controlling outbreaks. But by the 1980s, polio had been all but eliminated in the United States; all cases originating in the country came from the vaccine. Salamone and other parents successfully campaigned for the United States to shift to the safer version in the late 1990s.

Vaccines face a tougher safety standard than most pharmaceutical products because they are given to healthy people, often children. What they stave off is unseen, and many of the diseases are now rare, with their effects forgotten. So only the risks of vaccines, low as they may be, loom in the public imagination. A backlash against vaccination, spurred by the likes of Andrew Wakefield — a UK surgeon who was struck off the medical register after making unfounded claims about the safety of the measles, mumps and rubella (MMR) vaccine — and a litany of celebrities and activists, has sometimes overshadowed scientific work to uncover real vaccine side effects. Many false links have been dispelled, including theories that the MMR vaccine and the vaccine preservative thimerosal cause autism[1]. But vaccines do carry risks, ranging from rashes or tenderness at the site of injection to fever-associated seizures called febrile convulsions and dangerous infections in those with compromised immune systems.

Serious problems are rare, so it is hard to prove that a vaccine causes them. Studies to confirm or debunk vaccine-associated risks can take a long time and, in the meantime, public-health officials must make difficult decisions on what to do and how to communicate with the public. Still, such work is necessary to maintain public trust, says Neal Halsey, a paediatrician at the Johns Hopkins Bloomberg School of Public Health in Baltimore, Maryland. "If we don't do the research, there will be more people who don't believe in vaccines," he says.

Victims of their own success

Technological advances have made modern vaccines purer and safer than their historical counterparts. Most developed countries have switched to the inactivated polio vaccine and stopped using whole-cell pertussis (whooping cough) vaccines, which are made from killed bacteria and cause relatively high rates of arm swelling, febrile convulsions and periods of limpness or unresponsiveness.



Improved safety means that researchers are sometimes searching for vanishingly small risks. Although vaccines must undergo stringent safety tests before distribution, the trials typically don't enrol enough people to catch risks on the order of one case per 10,000–100,000 people (see 'Calculating risks'). The only way to find such side effects is to deploy the vaccine in the population and watch.

Officials have become increasingly vigilant. As worries about pandemic H1N1 influenza spread in 2009–10, several companies worked to prepare as many vaccine doses as possible. Meanwhile, health officials launched an unprecedented surveillance effort to monitor the vaccines' safety. US scientists and officials studied data from voluntary adverse-event reports, managed-care organizations, health-insurance companies, immunization registries, a network of neurologists and various health-care systems. European scientists linked data from 15 countries. And Chinese officials instructed health-care workers to report potential side effects within 24 hours; for the most serious events, they had two hours.

Scientists were specifically looking for Guillain-Barré syndrome, a paralytic disorder that is often treatable but can cause long-term disability or death. A 1976 swine-flu vaccine distributed in the United States was associated with between five and nine cases per one million vaccine recipients. Studies of subsequent flu vaccines have not shown a consistent link, but officials have been on the lookout for it. During the 2009–10 pandemic, something stranger turned up: some 60 cases of narcolepsy emerged among 4- to 19-year-olds in Finland. Most had received the H1N1 vaccine Pandemrix, made by GlaxoSmithKline in Brentford, UK. Another narcolepsy cluster showed up in Sweden. Scientists have yet to confirm whether the vaccine caused the rise in incidence.

Surveillance efforts have paid off for a variety of vaccines. A rotavirus vaccine was suspended in the United States in 1999 after public-health officials received 15 reports of intussusception, an infolding of the bowel, in vaccinated infants. The mechanism is uncertain, but the live-virus vaccine might cause swelling of bowel lymph nodes and increase contraction, leading to infolding. The vaccine is estimated to have caused about one case of intussusception per 10,000 recipients.

In 2007, Nicola Klein, co-director of the Kaiser Permanente Vaccine Study Center in Oakland, California, and her colleagues found that children aged between 12 and 23 months who had been immunized with a combination vaccine for measles, mumps, rubella and varicella (MMRV) had more febrile convulsions 7–10 days after vaccination than those receiving separate MMR and varicella vaccines. The finding prompted a US immunization advisory committee to withdraw its preference for the MMRV vaccine. A subsequent study[2] suggested that the combined vaccine resulted in one more febrile convulsion per 2,300 doses than the MMR and varicella vaccines given separately.

Efforts are under way to improve surveillance in low- and middle-income countries, some of which are gaining increased access to vaccines through an international programme called the GAVI Alliance (formerly the Global Alliance for Vaccines and Immunisation), based in Geneva, Switzerland. These areas could soon see new vaccines for diseases such as dengue and cholera. In 2006, the Pan American Health Organization, based in Washington DC, started a surveillance network among five Latin American countries. The World Health Organization (WHO) in Geneva is working with 12 countries, including Iran, Tunisia, Vietnam and India, to develop methods and tools for vaccine-safety monitoring, and half are already reporting to a global database, says Patrick Zuber, the WHO's group leader of global vaccine safety.

Researchers have also started conducting larger clinical trials. Pre-licensure trials for two new rotavirus vaccines, RotaTeq by Merck, based in Whitehouse Station, New Jersey, and Rotarix by GlaxoSmithKline, each enrolled more than 60,000 infants to evaluate safety[3,4]. But even these large trials cannot rule out rare events, so efforts would be better spent on well planned surveillance after licensing, argues Rino Rappuoli, global head of vaccines research at Novartis Vaccines and Diagnostics in Siena, Italy. With big pre-licensure trials, "you may feel better as a regulator, but you're not answering the scientific question", he says.

Preliminary post-licensure studies in Mexico have detected a possible slight increase in intussusception risk after the first dose of Rotarix, and a similar pattern has emerged in Australia for both vaccines[5]. However, some researchers speculate that rotavirus vaccination may also protect against intussusception later.

Delayed results, lost trust

Even if a possible side effect is found, long periods of uncertainty can follow. To amass convincing evidence, scientists sometimes need to do controlled studies in multiple countries, covering hundreds of thousands or even millions of people. Scientists have not yet conclusively determined whether Pandemrix contributed to the European cluster of narcolepsy cases.

Scientists in the Vaccine Adverse Event Surveillance & Communication Consortium, a European research network, are examining narcolepsy diagnosis rates and comparing cases with matched controls across several European Union countries, some of which used different H1N1 vaccines. Data suggest that diagnosis rates rose slightly in several countries starting in 2008, before H1N1 vaccines were being distributed, but not enough to explain the episode in Finland, says principal investigator Miriam Sturkenboom, a pharmacoepidemiologist at Erasmus University Medical Center Rotterdam in the Netherlands.

GlaxoSmithKline is also funding a study in Canada, where an H1N1 vaccine nearly identical to Pandemrix was used, but no rise in narcolepsy has been reported.

“If we don't do the research, there will be more people who don't believe in vaccines.”

The increase in narcolepsy diagnoses might be explained by heightened disease awareness or infections with the H1N1 virus itself, says Jan Bonhoeffer, a paediatric-infectious-disease specialist at the University Children's Hospital Basel in Switzerland, and chief executive of the Brighton Collaboration, an international vaccine-safety research network. He says that the narcolepsy story fits a familiar pattern, similar to that seen with MMR and autism: people are eager to find an underlying cause for a serious, chronic, poorly understood disease.

Researchers need to investigate possible safety issues quickly, Bonhoeffer adds. Otherwise, by the time scientists conclude that a concern is unfounded, "no one cares, and it takes years to build up the trust again", he says. "So often, the widely communicated concern has caused more harm than it intended to prevent." A

global vaccine-safety network would give scientists a faster way to test hypotheses with sufficient sample sizes, he says. In that spirit, the WHO is coordinating a global study on pandemic H1N1 flu vaccines and Guillain-Barré syndrome.

But strictly controlled randomized trials — the highest standard of evidence for determining causality — are often not possible because of the large number of participants needed. And randomized trials in one location will not prevent some researchers questioning whether the results apply in others, says Alfred Berg, a clinical epidemiologist at the University of Washington in Seattle.

Even if surveillance efforts became faster and more thorough, public-health officials still need to make quick decisions with incomplete data. Authorities often err on the side of caution, but warnings can make the public wary. In March, for example, Japanese officials suspended a vaccine for pneumococcal illnesses and one for Haemophilus influenzae type b when four children died shortly after immunization. Officials later concluded that there was no direct evidence of a link, but the episode still caused a scare, says Pier Luigi Lopalco, head of the vaccine-preventable-diseases programme at the European Centre for Disease Prevention and Control in Solna, Sweden. Suspending a vaccine tends to get more media attention than resuming one, he says, so people remember only the threat.

US government officials have drawn criticism for pushing for removal of thimerosal from vaccines, despite a lack of evidence that it poses a risk. "People said, why are you removing this if it's not a problem?" says Ken Bromberg, a paediatrician at the Brooklyn Hospital Center in New York. "It must really be a problem even though you say it's not." But inaction would have caused a loss of credibility, says Halsey. "That is not something I think the public would have accepted."

Finding those in danger

Researchers have long known that some individuals are more susceptible to vaccine risks than others. Immunocompromised individuals have generally been discouraged from receiving live-virus vaccines. But other possible vulnerabilities are less clear. Some speculate that children with metabolic disorders might be prone to vaccine side effects, but two studies published in April suggest otherwise. Klein and her colleagues reported[6] that children with inherited metabolic disorders do not show an increase in emergency-department visits or hospitalizations in the 30 days after being immunized. The other study found that children with one type of metabolic disorder — urea cycle disorders — did not have more serious metabolic problems than usual within 21 days of vaccination[7].

Some researchers hope that doctors will eventually be able to screen people for genetic predispositions to vaccine side effects. Gregory Poland, a vaccinologist at the Mayo Clinic in Rochester, Minnesota, says that once predispositions have been identified, genetic screening would at least make the risks and benefits explicit. Scientists have begun studying predispositions to side effects from smallpox vaccination: Kathryn Edwards, a vaccinologist at Vanderbilt University in Nashville, Tennessee, and her colleagues have reported[8] two genes that might be associated with reactions such as rashes, and Poland's team is searching for genetic risk factors for myopericarditis — inflammation of the heart muscle and surrounding tissue.

Even if immunization does prove risky for certain children, withholding the vaccine could pose a greater threat. Vaccine-preventable diseases can be particularly severe or even fatal for patients with metabolic disorders, says Marshall Summar, chief of the division of genetics and metabolism at the Children's National Medical Center in Washington DC.

Edwards and her colleagues have been studying how children with mitochondrial disorders, a group of metabolic disorders, respond to vaccines and natural infections. If vaccines present a risk, doctors could take steps to counteract possible effects, for example by ensuring that the child is well nourished after immunization, says Edwards.

Safer vaccines and manufacturing processes are also in the works. A Novartis plant in Holly Springs, North Carolina, will produce influenza vaccine doses in cell culture, rather than the industry-standard chicken eggs. This process will improve reliability and reduce allergic reactions to egg proteins, says Rappuoli. The plant will be ready to make pandemic-flu vaccine this year if needed, he says.

Researchers are also developing replacements for vaccines that can be risky for vulnerable groups. These include current smallpox vaccines that cannot safely be given to immunocompromised people; the

tuberculosis vaccine, which is not recommended for HIV-positive infants; and the yellow-fever vaccine, which puts elderly people at particular risk of a yellow-fever-like illness. The challenge will be to make safer vaccines just as effective: James Cherry, a paediatric-infectious-disease specialist at the University of California, Los Angeles, speculates that an outbreak of whooping cough in California in 2010 might have occurred partly because the safer acellular pertussis vaccines now in common use in developed countries tend to be less effective than the best whole-cell vaccines.

Researchers are quick to emphasize that the benefits of vaccines still greatly outweigh the risks. But as diseases recede from the public's memory, the population's tolerance for side effects will drop even further. "If you don't know the diseases and you haven't seen them, then you really aren't willing to accept any risk," says Edwards. Despite scientists' best efforts, eliminating risk is impossible. Vaccines are biological products with biological effects, says Juhani Eskola, deputy director general of Finland's National Institute for Health and Welfare in Helsinki. "We can never make them 100% safe."

See Editorial page 420

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Wildlife threatened by Fukushima radiation

Leaked isotopes likely to affect marine ecosystems more than terrestrial ones.
Quirin Schiermeier

Aquatic organisms, like seaweed, have been hit hard by the radioactive fallout from the Fukushima plant.Noriko Hayashi/Greenpeace

Radiation released by the tsunami-struck Fukushima Daiichi nuclear power plant could have long-lasting consequences for the natural environment in the vicinity of the damaged plant.

Scientists estimate that in the first 30 days after the accident on 11 March, trees, birds and forest-dwelling mammals were exposed to daily doses up to 100 times greater – and fish and marine algae to doses several thousand times greater - than are generally considered safe.

Radioecologists with the French Institute of Radioprotection and Nuclear Safety (ISRN) in Cadarache converted concentrations of radioisotopes measured in the soil and seawater into the actual doses that various groups of wildlife were likely to have received[1]. Their results are published this week in Environmental Science & Technology.

The soil samples used for the analysis came from a contaminated forest area 25–45 kilometres northwest of Fukushima. The seawater samples were taken from a region close to the reactor site. Both were measured in late March.

The French team reckons that about 50 radioisotopes have been released, with iodine-131 and caesium-137 being the most abundant (see 'Radiation release will hit marine life'). At the end of March, concentrations of caesium-137, which has a half life of 30 years, reached 47,000 becquerel per litre in seawater, and 72,900 becquerels per kilogram in soils. A becquerel is defined as one radioactive decay per second.

The team then plugged those concentrations into a piece of software called ERICA (Environmental Risk from Ionising Contaminants) to calculate the radiation dose that various groups of wildlife would have received. ERICA accounts for factors that are known to affect the rate at which organisms absorb radioisotopes, such as a species' cellular characteristics and metabolism. The dose rate (measured in milligrays per day) specifies how much radiation is absorbed per kilogram of organic tissue per day, a more biologically meaningful indication of how organisms are affected by exposure to radioactivity.

"Even so, it's just a rough assessment," says Thomas Hinton, a co-author of the study. "We need many more samples before we can try to determine the full extent of Fukushima's ecological effects."

The team found that flatfish, molluscs, crustaceans and brown seaweed offshore of Fukushima received radiation doses that, according to known dose-effect relationships, are likely to markedly increase mortality.

Terrestrial organisms are somewhat better off. However, the dose rates were still high enough to reduce the reproductive success of birds, rodents and trees – in particular pine and spruce.
"The reported values are not written in stone but they're definitely plausible," says Nick Beresford, a radioecologist at the Centre for Ecology & Hydrology in Lancaster, UK. "But even though it's preliminary, this is a very useful ecological assessment."

'Good' timing

Many land species, says Hinton, may get off relatively lightly because the accident happened early in the flowering season. Had it occurred in mid-spring, the harm would probably have been much more severe, especially for plants.
Radiation effects on egg hatching and the survival of newborn mammals still need to be surveyed, he cautions.
For all the problems it has caused, the Fukushima accident could help scientists to gain a better understanding of the effects of nuclear radiation on wildlife and the environment.
There is wild disagreement, for example, over how radiation affects the fitness of birds and invertebrates. A recent study[2] that reports reduced survival in barn swallows (Hirundo rustica) in the Chernobyl exclusion zone, where dose rates are now barely above natural values, has met with sharp criticism[3].
"Some researchers are reporting – possibly biased — results downright contrary to established paradigms of radioecology," says Hinton. "So what's going on? Long-term surveys in the Fukushima forest zone will hopefully help us find out."
Radioecologists regret that the few ecological studies done after the Chernobyl reactor meltdown 25 years ago missed out on many research opportunities and hope that the Fukushima area will become the natural observatory site that Chernobyl has not, owing mainly to political circumstances. The contaminated zone should ideally be thoroughly surveyed at least twice a year, says Hinton.
Amid more pressing priorities, the Japanese government is preparing an environmental monitoring programme that involves around 300 experts from across the country.
"They have all the expertise, no doubt," says Beresford, "and the sooner the work starts the more useful it will be."

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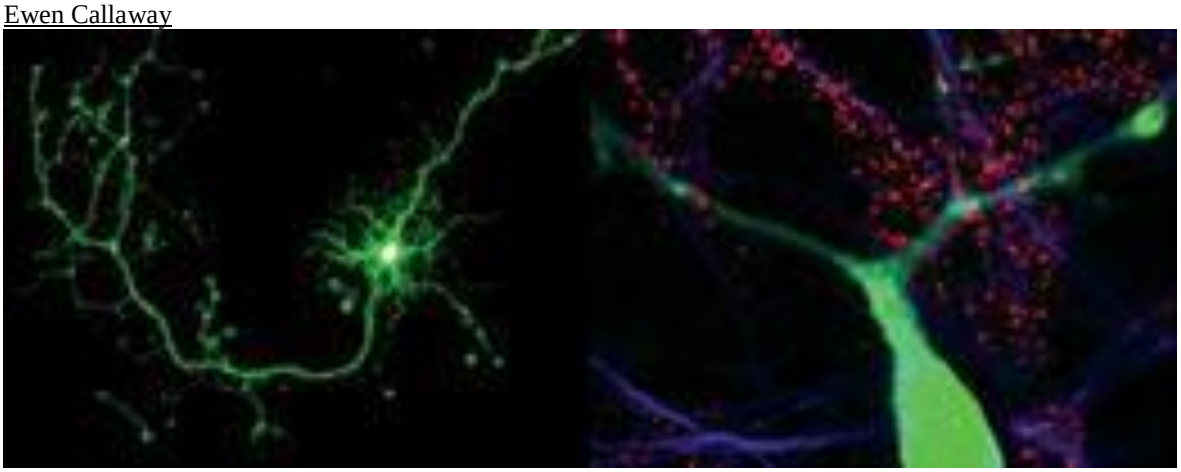
How to make a human neuron

Researchers have worked out how to reprogram cells from human skin into functioning nerve cells.
Ewen Callaway



Working neurons have been created from human skin cells.

By transforming cells from human skin into working nerve cells, researchers may have come up with a model for nervous-system diseases and perhaps even regenerative therapies based on cell transplants.

The achievement, reported online today in Nature[1], is the latest in a fast-moving field called transdifferentiation, in which cells are forced to adopt new identities. In the past year, researchers have converted connective tissue cells found in skin into heart cells[2], blood cells[3] and liver cells[4].

Transdifferentiation is an alternative to the cellular reprogramming that involves converting a mature cell into a pluripotent stem cell — one capable of becoming many types of cell — then coaxing the pluripotent cell into becoming a particular type of cell, such as neurons. Marius Wernig, a stem-cell researcher at Stanford University in California, and the leader of the study, says that skipping the pluripotency step could avoid some of the problems of making tissues from these induced pluripotent stem cells (iPSCs). The pluripotency technique can also take months to complete.

Wernig's team sparked the imaginations of cellular reprogrammers last year, when it transformed cells taken from the tip of a mouse's tail into working nerve cells[5]. That feat of cellular alchemy took just three foreign genes – delivered into tail cells with a virus – and less than two weeks. "We thought that as it worked so great for the mouse, it should be no problem to work it out in humans," Wernig says. "That turned out to be wrong."

Not quite right

Those three genes also made human cells that looked like nerve cells but that did not fire the electric pulses characteristic of neurons. However, the addition of a fourth virus-delivered gene, found through trial and error, pushed fibroblast cells — connective tissue cells found throughout the body and involved in wound healing — collected from aborted fetuses and the foreskin of newborns to become bona fide neurons. After a couple of weeks in culture, many of the neurons responded to electric jolts by pumping ions across their membranes. A few weeks later still, these neurons started to form connections, or synapses, with the mouse neurons they were grown alongside.

There are still kinks to work out, Wernig admits. Only 2–4% of the fibroblasts became neurons — lower than the roughly 8% efficiency his team achieved with the mouse tail cells. And most of the resulting neurons communicated using a chemical called glutamate, limiting their use for understanding or treating diseases such as Parkinson's, which is characterized by problems in neurons that communicate with this chemical. Wernig says that his team expects their efficiency to improve and is trying to make neurons that communicate using other chemicals.

Quick success

Neurons forged through transdifferentation offer advantages over brain cells made from iPSCs, says Evan Snyder, a stem-cell biologist at the Sanford Burnham Medical Research Institute in San Diego, California. As well as being quicker to make, they are less likely to form tumours when they are implanted into tissue, he says.

On the downside, however, cellular signs of disease may only appear when a cell develops naturally, from a pluripotent stem cell into a differentiated neuron, Snyder says. Forcing a cell into becoming a neuron could cause scientists to miss aspects of a disease. Furthermore, the fibroblasts that are the starting material for transdifferentiation do not divide as readily as iPSCs, limiting their use in applications that require lots of cells, such as drug screening, Wernig says.
"I would say that both approaches should be actively pursued because you never know for which cases and specific applications one or the other may be more suitable," Wernig concludes.

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Cambrian super-predators grew large in arms race

Metre-long anomalocaridids survived millions of years later than was thought.
Ewen Callaway

The giant Ordovician anomalocaridids were probably similar to this Cambrian Laggania.Esben Horn

The Cambrian Period's most ferocious predator clung to life for 30 million years longer than was previously thought. Fossils from Morocco show that sea creatures known as anomalocaridids survived long after they had been understood to have gone extinct, and their bodies grew to lengths in excess of one metre.

"Anomalocaridids are always depicted as these fierce horrible predators, ripping up things and tearing them apart — and no doubt some of them were," says Peter Van Roy, a palaeontologist at Yale University in New Haven Connecticut, who describes the findings today in Nature[1], with his colleague Derek Briggs. The creatures were thought to have died out by the end of the Cambrian Period, about 500 million years ago, but "this discovery shows that anomalocaridids persisted for a lot longer and were still very successful predators at the top of the food chain".

Although the latest fossils were unearthed in North Africa and the imposing invertebrates are known to have prowled oceans worldwide, anomalocaridids are inextricably linked with the Burgess Shale, a rock formation in western Canada that contains the fossils that helped to define the Cambrian explosion — a time when strange-looking marine animals proliferated.

Anomalocaridids are bizarre even by Cambrian standards. From the late nineteenth century onwards, fossils of various body parts from the creatures were discovered separately, and attributed to ancient relatives of shrimp, sea cucumbers, jellyfish and arthropods. Only in 1985 did Briggs and a colleague realize that these bits and pieces belonged to a single kind of animal, with two tentacle-like appendages at its head, a flat, segmented body and a mouth shaped like a pineapple ring with teeth projecting towards the centre. They named it Anomalocaris[2].

Fossil discoveries have since revealed that anomalocaridids came in diverse shapes and sizes — from Hurdia victoria, with its triangular carapace, to Schinderhannes bartelsi, with its long, pointed tail — and lived in the areas that are now Europe, the United States, Australia and China. But ancient relatives of sea scorpions and

nautiluses that emerged in the Ordovician Period (490 million–440 million years ago) were suspected to have out-competed the anomalocaridids, causing them to die out, says Van Roy.
In 2008, however, an amateur collector, Mohammed Ben Said Ben Moula, discovered specimens that looked like anomalocaridids, Van Roy says. But it wasn't until 2009, when the researchers took a trip to the Fezouata rock formation in southeast Morocco, that they realized just what Ben Moula had discovered.
The rocks were from the early Ordovician Period, about 488 million–472 million years old — much younger than any in which such fossils had previously been found. "It was quite an indescribable moment when you're putting these things together and suddenly you realize this is an anomalocaridid," says Van Roy.

Beast of the deep

One formation contained the splayed-out, headless body of a beast more than a metre long — nearly twice as large as any of its Cambrian brethren — and more than three times the size of even the largest of the other fossilized species from the same rocks.
None of those other hard-bodied fossils from Fezouata showed the tell-tale marks of an attack from an anomalocaridid's strange mouth, so Van Roy thinks that the one-metre monsters probably hunted soft-bodied invertebrates. Their victims may have been ensnared by the anomalocaridid's giant appendages and then delivered to its mouth.

Jan Bergström, a palaeontologist at the Swedish Museum of Natural History in Stockholm, says that the presence of anomalocaridids in the Ordovician is "surprising news".
Allison Daley, a palaeontologist at the Natural History Museum in London, says that it is difficult to know what caused the extinction of anomalocaridids, but she is still willing to pin the blame on competition from other marine predators, albeit later ones than had been thought — such as cephalopods that emerged during the Ordovician.
The giant bodies of the Fezouata anomalocaridids, Daley speculates, could be the result of an ecological arms race with the emerging predators — one that the Cambrian-era monsters lost. "I doubt there was a period of happy coexistence between the anomalocaridids and newly evolving Ordovician predators," she says.

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Massive Chilean dams approved

Decision widely condemned by citizens.
Elie Gardner

Chile hopes to reduce its dependence on imported fossil fuels by expanding hydroelectric power.CORBIS/EPA/ENDESA

Officials in Chile have approved a controversial US$3.2-billion project to construct five hydropower dams in Patagonia.

The HidroAysén project — a collaboration between the country's two biggest energy firms — plans to generate 2,750 megawatts of power by damming two major rivers, the Baker and the Pascua. But it must first seek approval for a 2,300-kilometre transmission line, costing another US$3.8 billion, that would carry power to Santiago.

The project was finally given the go-ahead after an arduous three years in the approval process. The Environmental Impact Assessment was first presented to the Environmental Assessment Commission of Coyhaique — a regional government body in southern Chile — in August 2008, but the commission wasn't satisfied with it and asked for an addendum.

Dozens of public organizations and thousands of individuals pointed out weaknesses in the study, saying that it lacked crucial information, ignored important issues, used incomplete data, misrepresented facts and contained poor analyses. The project had to submit the assessment three more times, responding to 4,046 comments, before it was finally approved.

Daniel Fernández, executive vice-president of HidroAysén, calls the study the "most extensive and comprehensive environmental assessment in the history of Chile".

No improvement

But those who criticized the original work say that many of their complaints still stand.

Claudio Meier, an engineer at Chile's University of Concepción who has been reviewing environmental-impact assessments for hydropower projects in the country for the past 20 years, was hired by Chile's water authority to review the original document. He says that the assessment was "built around anecdotal data" – for example, the studies on sediment were based on predictions and not actual measurements. What it lacked, in his opinion, was an understanding of ecosystem functions. For instance, the document reported impacts on water temperature, clarity and sedimentation, but did not address how these changes would affect the ecology of the rivers.

Peter Goodwin, founder of the Center for Ecohydraulics Research at the University of Idaho in Boise, says that rigorous scientific methods were not employed and the studies were not conducted over a long enough period to capture environmental variability, a problem made worse by the lack of pre-existing information on the pristine and remote Patagonian ecosystems.

"A baseline is important so you can detect in the future what the difference from normal is," Goodwin said. "Without a solid baseline study, you don't know what you are losing."

Orlando San Martin, an environmental adviser at Sweco, one of the consultancy firms commissioned to conduct the environmental assessment, says that his company, headquartered in Stockhom, did perform some extra baseline studies, but the project proposal and mitigation measures haven't changed much in the revision process. "The three revisions have allowed us to complement studies and reinforce mitigation measures in line with suggestions and requirements from the different governmental services participating in the environmental evaluation system," says San Martin.

Minimum requirements

Roberto Román, an engineer at the University of Chile in Santiago and vice-president of membership affairs at the International Solar Energy Society in San José de Maipo, says that the assessment shows that the project complies with Chilean law "at the lowest level that society is willing to accept".

But many say that the law needs to be made tougher. Román says that it should require a comparison to alternative projects, as is common in the United States and Europe. Meier, however, says that the assessment studied only the impact of the dam construction and not the impact of the transmission line. Because the line requires separate approval, they did not need be considered together.

Such renewable-energy projects have strong political support in Chile. The country imports 75% of its energy in the form of oil, gas and coal, and, according to statistics from the National Energy Commission, must double its energy capacity in the next 10–12 years to meet demand — although Román disputes that figure. But Chilean president Sebastián Piñera has said that the country needs a base of large, reliable power plants that use sources such as coal, hydro, or nuclear, arguing that renewable energy can't serve the country's needs cost-efficiently in the short term. HidroAysén says that Chile is using just 25% of its hydroelectric potential and promises to reduce the country's dependence on imported fuels.

http://www.nature.com/news/2011/110517/full/news.2011.297.html

Dubious assumptions prime population bomb

The United Nations says there could be 10 billion people on Earth by the end of the century. Fred Pearce finds problems in its analysis.

Fred Pearce

The latest global population projections, published by the United Nations last week, say that the world will be awash with 10.1 billion people by 2100, a billion more than previously supposed. Already, there is talk again of a ticking population time bomb.

But a closer look at the assumptions behind this scenario shows it to be perverse and contradictory. In fact, it looks more like a political construct than a scientific analysis.

The heart of the problem is this: the new UN estimates record that both world population and global fertility rates are currently slightly lower than presumed when the last projections were made two years ago. Yet, they project significantly higher growth rates than those estimated two years ago.

This paradox is created by a seemingly arbitrary change in assumptions about future fertility that requires a proper explanation. And quickly. Plans to cope with an increasing array of global challenges — not least climate change and food policy — are predicated on the UN's demographic projections. The past few years have seen a plethora of scientific papers asking 'can the world feed 9 billion?' It won't be long before the work is revisited to see whether we can feed 10 billion.

We are doing quite well at defusing the population bomb. Women today, on average, have half as many babies as their grandmothers did. World fertility has fallen from 4.9 children per woman in the early 1960s to an expected 2.45 between 2010 and 2015, a projection revised down from the 2.49 figure of two years ago.

The trend is near-universal. With childhood diseases such as measles and tetanus in retreat, for the first time in history most children get to grow up. Population quadrupled in the past century as this happened. But now women are learning to adjust to falling infant mortality and having fewer children. Other factors include urbanization. On a peasant farm in Africa, young children are an economic asset, minding the goats or fetching and carrying. Once families move to the cities, children are a liability, requiring years of education to get a job. Fertility rates are much lower in cities.

Falling fertility doesn't instantly translate into fewer babies. That is because of the huge demographic bulge of twentieth-century baby boomers — now adult and fertile. But as they age, and if fertility rates continue to fall, population growth must subside and could go into decline.

The key questions are how fast and how far fertility will fall. As the UN notes, "small variations in fertility can produce major differences in the size of populations over the long run". That is why the assumptions built into the new projections are so crucial.

The UN's previous 'medium variant' projection, published in 2008, concluded that world population would rise from the present 7 billion and peak in mid-century at around the 9.15 billion expected in 2050. The new projection finds no peak. Instead, world population reaches 9.3 billion in 2050 and 10.1 billion in 2100, with further growth still in the works.

The UN has yet to publish its detailed reasoning, but a collection of frequently asked questions issued alongside the new projections says that most of the difference is due to an upward revision of its fertility forecasts — a revision unrelated to current trends.

There is history to this. For many years, demographers reckoned that world fertility was headed inexorably for the rich-world replacement level of about 2.1 children per woman. But in the past 30 years, this has looked increasingly like too high a number. In almost all developed countries, fertility rates have fallen to well below replacement levels. Despite a minor bounce-back in recent years, most of Europe remains below 1.5.

"In almost all developed countries, fertility rates have fallen to well below replacement levels."

With much of Asia and Latin America on the same path, almost a decade ago the UN rethought the 2.1 end point. In 2003, its UN population division, under then-director Joseph Chamie, decided that its 'medium variant' projection should instead assume convergence at 1.85. It was a compromise, Chamie told me. Some argued for 1.6, whereas others wanted to retain 2.1. The latter group, he said, feared that a low estimate would send the 'wrong message' that our population worries were over.

The projections made in 2008 retained the figure of 1.85, but it has now reverted to 2.1 — the predominant reason for the leap from 9 billion to 10 billion. The assumption now is that countries with higher fertility rates will fall to the 2.1 figure and not below, while those below will rise to reach it.

Is this realistic? As Joel Cohen, a demographer at Columbia University in New York, put it in 2002: "No case is yet known of a population with fertility above replacement level that converged to replacement level and then stayed there." That remains the case. Chamie this week said he had seen "no compelling evidence" to justify a return to the 2.1 figure.

The UN boasts that its new projections have incorporated a more probabilistic approach into the model. That is good. But, as the UN makes clear, the model "incorporated the additional assumption that, over the long run, replacement-level fertility would be reached". In other words, the crucial new fertility end point of 2.1 did not emerge from the new probabilistic analysis. It was imposed on it, and the UN should explain why.

Fred Pearce, environment consultant for New Scientist, is author of Peoplequake (Eden Project Books, 2010) and is speaking at a conference on population footprints at University College London on 25–26 May (http://www.populationfootprints.org). e-mail: pearcefred@hotmail.com

http://www.nature.com/news/2011/110511/full/473125a.html

Puzzle persists for 'degradeable' plastics

Eco-friendly plastics disintegrate, but might just linger in the environment.
Daniel Cressey

Going nowhere fast: 'degradable' plastic bags are not as helpful to the environment as hoped.Punchstock
The environmentally friendly version of polythene might not be so friendly after all.
Polyethylene is one of the most widely used materials in the world, and the discarded plastic bag has become one of the most potent symbols of human impact on the environment. As worries over the vast scale of waste from this plastic has grown, so has the use of purportedly 'degradable' forms of it.
Adding transition metals such as iron and cobalt can promote the oxidation of the ethylene polymers and claims for the degradability or biodegradability of these materials are widespread on food packaging and plastic bags. But a review published last week in Environmental Science & Technology[1], notes that there is no evidence that 'degradable polyethylenes' are actually all they suggest.
Although it is clear that 'degradable' plastic bags, for example, will fall apart in the environment, the resulting fragments can persist for a long time, and there are no long-term studies on these pieces. A key issue is that products can be described as biodegradable without reference to the timescale it takes them to fully biodegrade.
"There are a tremendous number of papers about degradable polyethylene but no one has really shown a high degradation," says Ann-Christine Albertsson, a polymer researcher at the Swedish Royal Institute of Technology (KTH) in Stockholm and lead author on the critical review. "Of course they degrade in one way – they are losing part of their properties. But if you mean it as a positive for nature, that has not been proved."
Developing-world countries such as China are also starting to use 'degradable' polyethylene, says Albertsson. Indian authorities have taken an interest in the subject, and recently sent a postdoc to work with her. Although some countries are already trying to move to genuinely degradable products based on starch-based polylactide, this is still expensive. And paper-based products may not be a suitable replacement because of the requirement to cut down trees.

Burn it up

Noreen Thomas, a materials researcher at Loughborough University, UK, was one of the authors of a 2010 report for the UK Department for Environment, Food and Rural Affairs (DEFRA) on oxo-degradable plastics[2]. These are mainly polyethylene but also include some types of polypropylene.
How quickly the plastic will break down into fragments is heavily dependent on heat and light exposure – and hence on the environment the plastic ends up in. The Defra report suggests that oxo-degradable fragments left outside in the United Kingdom would become small fragments over two to five years. The biodegradation of these small fragments then proceeds "very slowly", it notes.
"Our conclusion was there is no benefit to the environment of oxo-degradable plastics," Thomas told Nature.

These plastics should not be composted, as their breakdown fragments will ruin the resulting compost. But neither can such materials be incorporated into traditional plastics recycling as the same additives that encourage the break-up of the original material will degrade the recycled material produced.
The report recommended that these plastics should be kept out of conventional plastics recycling in favour of incineration or landfill.
The Defra-authored summary of the report points out, "Both of these options make the 'degradable' property of oxo-degradable plastics irrelevant."

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Oil spills underreported in Gulf of Mexico

Coast Guard's self-reporting system may paint an incomplete picture.
Melissa Gaskill

Oil slicks that are much larger than the reported spills could have created have been seen.D. Beltra/Greenpeace/naturepl.com

There is only one official source of data on pollution caused by offshore drilling in US waters: the National Response Center, an online reporting system for oil and chemical spills managed by the US Coast Guard. But watchdog groups say that the system's reliance on self-reporting means its data are fundamentally flawed.

One of those groups is SkyTruth of Shepherdstown, West Virginia, founded by geologist John Amos in 2001 to monitor the effects of human activity on the environment using remote-sensing and mapping technologies. Amos monitored satellite images of the Gulf of Mexico during the Deepwater Horizon disaster, noticed a separate slick, and traced it to the former Taylor Energy platform 23051.

According to NRC reports analyzed by Amos, an average of 14 gallons per day had been spilling from that rig for several months, says Amos. "But our image analysis shows the leak rate must be greater, possibly by a factor of 10." Assuming oil needs to be at least 1 micrometre thick to create a visible sheen, he explains, and assuming that an oil slick that thin has a 72-hour lifespan at the surface, a leak of 14 gallons per day could only create a visible sheen 1.6 kilometres long by 91 metres wide. "We repeatedly observed, and NRC reports describe, slicks much larger," Amos says.

Small claims

It is a common problem. Amos had previously found a slick nearly 34 km long that was blamed on a spill of just 7 gallons (See Skytruth's reports).

Then, in March 2011, oil washed ashore on Grand Isle, Louisiana. Workers at the Department of Wildlife and Fisheries traced the spill to an apparent source at West Delta Block 117, about 32 km to the south west. Anglo-Suisse Offshore Partners (ASOP) of Houston, Texas, had reported three discharges from its Platform E there, totalling less than 5 gallons. But, says Amos, "enough came ashore that the Coast Guard had to mount a clean-up response, which certainly suggests more than a few gallons".

The Coast Guard collected oil samples from the ASOP well and the slick, which were sent to Louisiana State University in Baton Rouge for chemical fingerprinting. Ed Overton, professor emeritus at the university's School of the Coast and Environment, says the samples matched. "All oil contains the same molecular

structures, but oil from different sources contains different levels of hundreds of various compounds," says Overton, who developed the first methods for analyzing components as a method of "fingerprinting" oil samples in the late 1970s, and has continued to be involved in refining the technology[1].

ASOP did take responsibility for the clean-up, which had been largely completed by 6 April, but the company did not return phone calls from Nature requesting comment.

Amos thinks that the Taylor and Grand Isle incidents illustrate the reporting system's flaw. "There is a strong incentive to under-report incidents. Who is going to get in a helicopter and fly 50 miles offshore for a 2-gallon spill? You report so you won't get fined, but report small because you know that will keep everybody behind their desks. We need some kind of independent verification."

The Coast Guard conducts a telephone investigation of every report, according to Petty Officer Nathan Thompson, and determines an appropriate course of action on the basis of that. There is no threshold amount that triggers a response. "It depends on the location, the reporting party and other factors," Thompson says. "If a company had a history of a lot of spills, or if a spill occurred in a more environmentally sensitive area, we'd probably go out. Sometimes we have to prioritize. In Louisiana, we get a lot of reports of spills from unknown sources, and we go out to those every single time."

Guessing game

Overton also suspects that spills are routinely underestimated given that fines are linked to volume, but points out that estimating spill volume is not an exact science. "Sheens can cover a lot of area and not represent much oil," he explains. "We need research on better spectral methods to estimate the thickness of sheens."

More accurate data are vital as offshore drilling ramps back up post-Deepwater Horizon, Amos says. "NRC reports are the only comprehensive offshore spill database. But if the government and citizens rely on them to know how much pollution is caused by offshore oil and gas production, our drilling policy is based on fundamentally inaccurate data."

Accurate or not, the data are difficult to use, says Eric Schaeffer, former head of civil enforcement at the US Environmental Protection Agency and now director of the non-profit organization the Environmental Integrity Project, headquartered in Washington DC. "The data are pretty scattered, nomenclature is not consistent. At the time of release, you don't necessarily know how much has spilled, yet have an immediate obligation to report. But there isn't correction and updating of information later. Simple things such as spelling out how you did the numbers would be really valuable."

Carrie Beth Lasley, a researcher at the University of New Orleans Center for Hazards Assessment, Response and Technology, adds that mandatory annual inspections of platforms — or at the very least after a hurricane — are also needed.

Amos would like someone to monitor satellite images to identify unreported and under-reported spills. "We were able to document the leak from the Taylor platform because, during the BP spill, multiple satellite imaging systems were trained on that part of the Gulf on a daily basis," he says. "But once BP was plugged, the data stream slowed to the normal daily trickle. Satellites are overhead all the time, but only on when a paying customer wants an image."

The hardware and personnel for a Gulf-wide monitoring system already exist, he notes, at the University of Miami's Center for Southeastern Tropical Advanced Remote Sensing in Florida. "We have tremendous assets we aren't using, and that's a shame."

As part of an effort to rectify this, on 19 April, SkyTruth announced it was forming a consortium with North Carolina-based SouthWings, a non-profit organization of private pilots, and Waterkeeper Alliance, a worldwide organization promoting clean water, to monitor pollution. "It's a coordinated approach, SkyTruth using satellite images to detect and map potential oil slicks and pinpoint potential sources, SouthWings and Waterkeeper using that information to coordinate overflights and on-the-water investigations and sampling," Amos says.

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Reform the PhD system or close it down

There are too many doctoral programmes, producing too many PhDs for the job market. Shut some and change the rest, says Mark C. Taylor.

Mark Taylor

The system of PhD education in the United States and many other countries is broken and unsustainable, and needs to be reconceived. In many fields, it creates only a cruel fantasy of future employment that promotes the self-interest of faculty members at the expense of students. The reality is that there are very few jobs for people who might have spent up to 12 years on their degrees.

Most doctoral-education programmes conform to a model defined in European universities during the Middle Ages, in which education is a process of cloning that trains students to do what their mentors do. The clones now vastly outnumber their mentors. The academic job market collapsed in the 1970s, yet universities have not adjusted their admissions policies, because they need graduate students to work in laboratories and as teaching assistants. But once those students finish their education, there are no academic jobs for them.

"Most doctoral programmes conform to a model defined in the middle ages."

Universities face growing financial challenges. Most in the United States, for example, have not recovered from losses incurred on investments during the financial fiasco of 2008, and they probably never will. State and federal support is also collapsing, so institutions cannot afford to support as many programmes. There could be an upside to these unfortunate developments: growing competition for dwindling public and private resources might force universities to change their approach to PhD education, even if they do not want to.

There are two responsible courses of action: either radically reform doctoral programmes or shut them down. The necessary changes are both curricular and institutional. One reason that many doctoral programmes do not adequately serve students is that they are overly specialized, with curricula fragmented and increasingly irrelevant to the world beyond academia. Expertise, of course, is essential to the advancement of knowledge and to society. But in far too many cases, specialization has led to areas of research so narrow that they are of interest only to other people working in the same fields, subfields or sub-subfields. Many researchers struggle to talk to colleagues in the same department, and communication across departments and disciplines can be impossible.

If doctoral education is to remain viable in the twenty-first century, universities must tear down the walls that separate fields, and establish programmes that nourish cross-disciplinary investigation and communication. They must design curricula that focus on solving practical problems, such as providing clean water to a growing population. Unfortunately, significant change is unlikely to come from faculty members, who all too often remain committed to traditional approaches. Students, administrators, trustees and even people from the public and private sectors must create pressure for reform. It is important to realize that problems will never be solved as long as each institution continues to act independently. The difficulties are systemic and must be addressed comprehensively and cooperatively. Prestige is measured both within and beyond institutions by the number and purported strength of a department's doctoral programmes, so, seeking competitive advantage and financial gain from alliances with the private sector, universities continue to create them. As is detailed on page 276, that has led most fields to produce too many PhDs for too long.

The solution is to eliminate programmes that are inadequate or redundant. The difficult decisions should be made by administrators, in consultation with faculty members at their own and other universities, as well as interested, informed and responsible representatives beyond the academic community who have a vested interest in effective doctoral education. To facilitate change, universities should move away from excessive

competition fuelled by pernicious rating systems, and develop structures and procedures that foster cooperation. This would enable them to share faculty members, students and resources, and to efficiently increase educational opportunities. Institutions wouldn't need a department in every field, and could outsource some subjects. Teleconferencing and the Internet mean that cooperation is no longer limited by physical proximity.

Consortia could contain a core faculty drawn from the home department, and a rotating group of faculty members from other institutions. This would reduce both the number of graduate programmes and the number of faculty members. Students would have access to more academic staff with more diverse expertise in a wider range of fields and subfields. Faculty members will resist, but financial realities make a reduced number of posts inevitable.

Higher education in the United States has long been the envy of the world, but that is changing. The technologies that have transformed financial markets and the publishing, news and entertainment industries are now disrupting the education system. In the coming years, growing global competition for the multibillion-dollar education market will increase the pressure on US universities, just when public and private funding is decreasing. Although significant change is necessary at every level of higher education, it must start at the top, with total reform of PhD programmes in almost every field. The future of our children, our country and, indeed, the world depends on how well we meet this challenge.

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Gut study divides people into three types

Bacterial populations fall into three distinct classes that could help to personalize medicine.
Nicola Jones

You have one of three different populations of microbes in your gut.MedicalRF.com/Getty Images

Just as there are a few major blood types that divide up the world, so too, a study has found, there are just three types of gut-microbe populations. The result could help to pinpoint the causes of obesity and inflammatory bowel disease, and to personalize medicine.

"This is important. Say you want to compare ill people and healthy people; you better match them properly [by gut type]," Dusko Ehrlich told Nature at a human microbiome conference in Vancouver, Canada, in March. Ehrlich, a senior researcher on the paper published in Nature today[1], is director of the Microbial Genetics Research Unit at the National Institute for Agricultural Research in Jouy-en-Josas, France, and part of a European consortium aiming to unpick links between gut microbes and disease.

The finding of just three types of gut-microbe population was an unexpected result that fell out of the team's early analysis. The types aren't related to age, gender, nationality or diet. "What causes it? We don't know," says Ehrlich.

One possible explanation, which the team is testing, is that a person's gut-microbe make-up is determined by his or her blood type. Alternatively, it might be determined by metabolism: there are three major chemical pathways by which people get rid of excess hydrogen gas created during food fermentation in the colon, and the gut type might be linked to those. Or, perhaps the first microbes a baby is exposed to as his or her immune system is developing determines the type.

A person's gut type might help to determine whether people can eat all they like and stay slim, whether they will experience more gut pain than others when sick and how well they can metabolize a certain drug.

It's unclear whether a person's gut type might change over time, either naturally or in response to something such as a steady diet of probiotic yoghurt.

Little helpers

Researchers have only recently begun to appreciate the importance of the bacterial cells that grow on and in our bodies, outnumbering our own cells by about ten to one. In rodents, gut microbes are known to influence weight and immunity against disease (see 'For mice, swapping fecal bacteria can mean life or death'). In the United States, the Human Microbiome Project is aiming to catalogue all the microbes living in our nose, mouth, skin, gut, and urinary and genital tracts; in Europe, the Metagenomics of the Human Intestinal Tract (MetaHIT) Consortium, the group to which Erlich belongs, is focusing on the gut.

For this paper, the team used genetic screening to identify the microbes present in faecal samples from 22 Europeans enrolled in other gut-microbe studies, and compared the results with samples from 17 people in the United States and Japan. When they looked to see how similar the samples were, the researchers found that

they clustered neatly into three groups. "We were very surprised," says Peer Bork of the European Molecular Biology Laboratory in Heidelberg, Germany, also a senior author on the paper. Although the number of samples in this paper is small, Bork says that his team now has results from more than 400 samples and that the clustering is still evident.

"I was surprised too. I thought it would be much more chaotic," says Brett Finlay, a microbiologist at the University of British Columbia in Vancouver.

Fat or thin

The team has named the clusters after the dominant genus: Bacteroides, Prevotella and Ruminococcus. Bacteroides are known to be good at breaking down carbohydrates, so it is possible that people of this type might, for example, struggle more with obesity, says Bork. Prevotella tend to degrade slimy mucus in the gut, which could conceivably increase gut pain. And some Ruminococcus help cells to absorb sugars, which might contribute to weight gain.

Bork cautions, however, that each person carries a complex mix of perhaps a few thousand bacterial species, and too little is known to make sweeping generalizations about the implications of the different gut types. The team has, however, found hints that one particular disease — Bork won't yet say which one — is found only in people of one microbial gut type.

The team also has a host of as-yet-unpublished results that link specific gut-bacteria species to individual characteristics. "If I have a stool sample I can tell how old you are," says Bork. "That seems useless because you already know how old you are, but it's proof of principle that it could maybe be used for all sorts of other things." Ehrlich says that his team can diagnose obesity with an accuracy of 80-85% from half a dozen bacterial species.

"The real question is: what is the gene set we need in our guts to be healthy?" says Finlay. That has yet to be answered.

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http://www.nature.com/news/2011/110420/full/news.2011.249.html

Chimps give birth like humans

Humans are not alone in having infants that emerge facing backwards.
Joseph Milton

Chimps and humans have much in common, inlcuding the way they give birth.Georgios Kefalas / Keystone / AP Photo

A key feature of human childbirth, long thought to be unique to Homo sapiens — the arrival of the baby facing backwards relative to its mother — has been observed in our closest living relatives, chimpanzees.

The discovery, reported today in Biology Letters[1], calls into question the argument that backwards-facing babies were an important factor in the evolution of midwifery in humans. Rather than searching for assistance when they go into labour, pregnant chimps seek solitude.

"It's clear from our observations that chimp babies are born facing backwards, but they give birth alone," says lead author Satoshi Hirata, a behavioural biologist at the Great Ape Research Institute of Hayashibara Biochemical Laboratories in Tamano, Japan. "So the reverse orientation is clearly not a necessary condition for the evolution of midwifery."

Remarkably, before Hirata and his colleagues filmed three captive chimpanzees giving birth, nobody had observed chimp parturition at close quarters, and the animal's young were assumed to be born facing forwards, as are those of many other non-human primates. Click here to see one of the team's videos.

Hirata thinks this is probably because the timing of birth is unpredictable, and because pregnant females do not like company when they give birth. "They get very nervous," he says.

Close relationship

The researchers were able to observe the births only because of their very close relationship with the animals they study. "We even sleep in the chimpanzee enclosures every night," says Hirata, "so we could be in the same room as the pregnant females and record the behaviour from a very close distance."

Hirata says that, during the births, he and his co-workers had no idea that they were witnessing something so momentous. It was only thanks to a discussion with a human-childbirth researcher that the importance of their observations came to light. "She was very surprised to see the orientation of the baby, so we decided to write a paper about it," Hirata says.

The idea that babies being born backwards — making it difficult for the mother to pick up and nurture the child — may have been instrumental in the evolution of midwifery was first suggested by anthropologists in the 1980s.

"But their arguments were not based on clear comparative data from non-human primates," says Hirata. "Now our data have clearly shown that's not the case."

Unusual humans

Wenda Trevathan, a biological anthropologist at New Mexico State University in Las Cruces, was one of the first to suggest that fetal orientation played an important part in the evolution of midwifery[2].

"It's taken 25 years for people to start reporting some observations that help confirm or refute my hypothesis," she says, "so I'm glad that finally we've got some observational data on chimpanzees — it's advancing science."

Trevathan says there are still aspects of human labour that make it "unique, or at least very unusual". "One is the series of rotations that the fetus undergoes as it is born — I'm not sure that's been called into question," she says. "Another is routinely seeking assistance."

She adds that the orientation of the human infant still provides a compelling explanation for the evolution of midwifery in humans because "assistance definitely facilitates delivery when the baby comes out in that position".

She also thinks her arguments have often been misinterpreted. "I have never said assistance is a necessity in human childbirth, but rather that it's beneficial."

Trevathan thinks that the pertinent question is not why humans have evolved midwifery, but rather why chimps have not.

Although the study does not tackle that question, it certainly helps to quash the outmoded idea that humans are distinct from the rest of the animal kingdom. "In a broad sense I think humans tend to believe we are unique," says Hirata, "but that belief is not based on facts."

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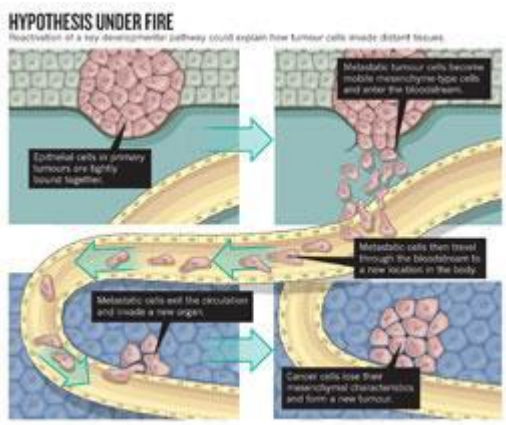
Cancer theory faces doubts

A leading explanation for how disease migrates falls short on clinical evidence.
Heidi Ledford
It can't be easy to stand in front of hundreds of colleagues and tell them that ten years of research has led them in the wrong direction. But at the annual meeting of the American Association for Cancer Research (AACR) earlier this month, pathologist David Tarin did just that, by challenging a leading hypothesis on how cancers metastasize.
Tarin, from the University of California, San Diego, questioned the idea that cancer cells break free and migrate to new sites in the body by reverting to a state resembling the mobile cells in the developing embryo. Lab evidence for the hypothesis has raised hopes of some day blocking metastasis, which in 90% of cancer deaths is what ultimately kills the patient. But Tarin, along with some other cancer biologists, argues that no one has seen the process in action in human cancers.



Most cancers occur in the sheets of epithelial cells that line organs. Epithelial cells are normally immobile, but during embryonic development some start to produce proteins associated with motility and shut down production of proteins that glue the cells together. This transforms the cells into more mobile 'mesenchymal' cells that migrate to their correct locations in the embryo. If the same epithelial-to-mesenchymal transition (EMT) takes place in cancers, it could explain how tumour cells detach from their neighbours and enter the bloodstream to seed a new tumour (see 'Hypothesis under fire').
"It's a nice concept," says Pierre Savagner, a cancer researcher at the Montpellier Cancer Research Institute in France. "It makes things relatively simple to understand."
Although controversial at first, the EMT hypothesis was bolstered by experiments in mice showing that activation of EMT led to metastasis. OSI Pharmaceuticals, based in Melville, New York, is already pursuing EMT inhibitors as possible cancer treatments, as are several academic labs.
"EMT is really becoming a popular subject," says Shoukat Dedhar, a cancer researcher at the British Columbia Cancer Research Centre in Vancouver and a self-avowed convert to the hypothesis. "There are more and more data coming out for EMT's role in metastasis."
Yet sceptics remain. Tarin, among others, is concerned that the hypothesis has achieved popularity on the basis of results from cultured cells and animal models, without convincing evidence of its importance in metastasis in humans. He argues that pathologists have combed through millions of tissue sections from tumours without seeing cells in transition.

Conflicting ideas

Champions of the EMT–metastasis hypothesis, including leading cancer biologist Robert Weinberg at the Whitehead Institute for Biomedical Research in Cambridge, Massachusetts, say that this may simply be because EMT is so transient — once a metastatic cell has invaded a new tissue, its mesenchymal features melt away. "When we examine a piece of tissue from a patient, we have just a snapshot of a moment," agrees cancer researcher Gianluigi Giannelli of the University of Bari Medical School in Italy. "We don't see the full movie."

Tarin dismisses this reasoning. "It's comparable to one telling you there are invisible aliens sitting in this room," he told the crowd at the AACR meeting, "but because you haven't used the right tools, you haven't seen them."
Others echo his concerns. Savagner points out that the proteins that might indicate EMT activation are also present during unrelated processes, such as programmed cell death. "People really want these cells to do an EMT and they push the concept too far," he says.
Even Dedhar worries about overreaching claims. For example, many papers report results from cultured cells, he says, without confirming that the cells are metastatic in live animals.
The real picture, Tarin says, may not involve a change in cellular identity. Instead, he and others suggest that metastasis occurs when mutations in cancer cells compromise cell–cell adhesion. Others suggest that cells break off from the tumour in clumps and travel in packs.

Weinberg says a key experiment that could resolve the controversy would be to track individual cancer cells from the time they break off from a tumour to the point at which they colonize a new organ. Such an experiment would be technically challenging in humans, he says. "One can study the primary tumour and the cells it dispatches into the circulation," Weinberg says. "But finding out what happens to these circulating tumour cells after they become lodged is very difficult."
"Whether this process is mandatory for metastasis to occur is still unclear," says Isaiah Fidler, a cancer biologist at the M. D. Anderson Cancer Center in Houston, Texas. "But EMT is not to be dismissed. In cancer, we can't dismiss anything."

http://www.nature.com/news/2011/110419/full/472273a.html

What makes a resilient reef?

Local factors can help coral survive global heat waves.

Christopher Pala

Concentrating on protecting the reefs best able to endure climate change is the most effective conservation strategy.Borut Furlan/WaterFrame/Still Pictures

Researchers from East Africa have come up with a model that could help protect coral reefs beset by warming waters. The team has worked out that such factors as winds, currents and light can help reefs survive heat waves.

The study leader, Tim McClanahan, a Kenya-based coral biologist with the Wildlife Conservation Society, headquartered in New York, has been familiar with the problems faced by conservation bureaucrats tasked with protecting coral reefs from overfishing and other human damage: so many reefs, so little money.

So he decided to help them decide where to concentrate their limited resources to maximize the efficiency of conservation.

"There are perhaps 12,000 square kilometres of healthy reefs left in the western Indian Ocean and these officials know they can't protect them all," says McClanahan. "What we've done is help them concentrate their resources on the reefs that are most likely to survive global warming, at least for another century. The model can now be applied anywhere in the world."

The key criteria, pinpointed by McClanahan and other researchers in Global Change Biology[1], include winds, currents, UV light and visible light, temperature variability and chlorophyll in the water. They found that even in regions where the water was hot, some reefs survived because these local factors were favorable.

A severe global heat wave in 1998 killed half of the region's shallow corals. The study identifies which will be the most likely to recover from the next spike. "It's not a lot," says McClanahan, who is based in Mombasa, Kenya. "It's about 40 sites that, put together, amount to maybe 1,500 square kilometres."

Coral-reef task forces set up by the Nairobi Convention on coastal environments in the East African states have been struggling to establish which Indian Ocean reefs should be enclosed in Marine Protected Areas (MPA) where fishing would be restricted.

"This study provides the scientific backing we need to lobby for the targeted placement of MPAs in the region," says Nyawira Muthiga, chairman of the Regional Coral Reef Task Force in Mombasa and a co-author of the study.

Mapping survival

An earlier study[2] found that satellite surveys of temperatures from the region were not good indicators of which reefs survived the 1998 heat wave, so they added a total of nine variables.

"This model," co-author Joeph Maina of Macquarie University, in Sydney, Australia, says, "was a good predictor of what areas would be bleached in the future. Then we noticed that more than half the MPAs in the western Indian Ocean were in those high-risk areas, which would appear to be unwise." The coral reef task forces used the study to establish guidelines on where to establish MPAs.

"We found that barely 20% of the areas with high biodiversity that would normally be candidates for protection will likely survive the next temperature spike, and those are the ones that should to the top of the list of candidates," adds McClanahan.

Topping the list of regional reefs that should be preserved are Mozambique's Quirimbas Archipelago and Ponta do Ouro, a thriving diving centre sustained by tourists from neighbouring South Africa; and reefs off northeast Madagascar, which has one of the richest diversity of species in the region. In all three, restrictions on fishing are weak or non-existent and need to be increased.

"This paper shows that even if temperatures and acidification will eventually kill most corals, if you can buy a few decades by good local conservation measures, you should fight for it," says Charles Sheppard, a coral biologist at the University of Warwick in Coventry, UK, who predicted in 2003 that most Indian Ocean corals would die by 2050[3].

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A death in the lab

Fatality adds further momentum to calls for a shake-up in academic safety culture.
Richard Van Noorden

Fellow students hold a vigil for Yale undergraduate Michele Dufault.THE YALE DAILY NEWS

In the early hours of 13 April, undergraduate students working at Yale University's Sterling Chemistry Laboratory made a shocking discovery. There in the lab's machine shop was the dead body of 22-year-old undergraduate student Michele Dufault, her hair tangled in a lathe. She had apparently died of asphyxiation in an accident described by Richard Levin, president of Yale in New Haven, Connecticut, as a "true tragedy". Within days, federal health and safety officials had started to investigate. Details are scarce, but it is already clear that Dufault was not inexperienced with the equipment; she had taken a training course and had used the lathe safely many times before, according to fellow physics student Joe O'Rourke. She was, however, working late at night and probably alone (a speculation that Yale would not confirm) — circumstances that were not unusual at the machine shop, says O'Rourke.

Around the United States, laboratory directors and safety officers immediately checked their own policies on working practices in machine shops. But the accident has also heightened wider concerns about the ever-present tension between research freedom and safe working conditions in academia. And it underscores the slow pace of change since another high-profile laboratory fatality led to similar soul-searching less than three years ago.

In late 2008, 23-year-old research assistant Sheharbano Sangji sustained horrific burns in a lab fire at the University of California, Los Angeles (UCLA), and died of her injuries 18 days later. Sangji's death — in very different circumstances from Dufault's — resulted in federal fines for the university and a rapid toughening of safety policies there. On 30 March, UCLA unveiled its latest safety initiative: a new Center for Laboratory Safety, which is billed as the first in the United States to measure the effectiveness of safety policies and develop ways to improve scientists' approach to safety. More widely, Sangji's accident acted as a lightning rod for demands to improve standards across the United States.

Sheharbano Sangji (left) and Michele Dufault.FACEBOOK


Yet for all this attention, health and safety experts say that they have not seen a significant shift in the behaviour of bench scientists or the attitudes of lab heads, who are in the best position to improve safety culture. "It's very difficult to change principal investigators' attitudes," says James Gibson, UCLA's director of environmental health and safety. All too often, researchers in laboratories around the country still work alone, and without proper supervision or protection. "In many cases, academic freedom is more important than safety," says Jim Kaufman, president of the Laboratory Safety Institute in Natick, Massachusetts.

Chemical focus

Although such concerns apply across academia, accidents in chemistry laboratories have drawn the most scrutiny in recent years. A year after Sangji's death, Preston Brown, a graduate student in chemistry at Texas Tech University in Lubbock, lost three fingers of his left hand during a dangerous experiment. Brown was grinding up chunks of nickel hydrazine perchlorate — using a hundred times the recommended amount — when it detonated.

Unusually, the US Chemical Safety Board (CSB) — a body that usually investigates large industrial accidents such as refinery explosions — stepped in. For the first time ever, it said it would review academic laboratory safety. At an August 2010 meeting of the American Chemical Society in Boston, Massachusetts, CSB chairman Rafael Moure-Eraso said that the board had gathered media reports of around 120 university chemistry laboratory accidents since 2001, and concluded that "safety practices at US universities leave a lot to be desired".

Chemistry labs have been a particular focus of concern because the most dangerous procedures in other sciences tend to have more detailed safety protocols, says Peter Reinhardt, head of environmental health and safety at Yale University. "Using radioactive materials or biological materials is much more stringently regulated," he told Nature (speaking before Dufault's accident). "The big gap is hazardous chemicals in laboratories."

Rick Danheiser, an organic chemist at the Massachusetts Institute of Technology in Cambridge who chairs the chemistry department's health and safety committee, agrees that some labs' safety standards are too lax. But "there are chemistry departments with very strong safety programmes, and there's a whole range of laboratories in between", he says.

Neal Langerman, who runs the consulting company Advanced Chemical Safety, based in San Diego, California, is more strident about the extent of the problem. "I have come to the conclusion that most academic laboratories are unsafe venues for work or study," he wrote in a 2009 opinion column in the Journal

of Chemical Health and Safety. He now says that, despite the recent accidents, he has not noticed a significant change in chemists' attitude to safety.
US scientists are undeniably much safer today than before swathes of occupational health legislation arrived in the 1970s, along with a new watchdog agency, the federal Occupational Safety and Health Administration (OSHA). Further improvements came in 1991, when OSHA stipulated that each chemistry lab should prepare a 'chemical hygiene plan' — effectively a handbook detailing safety protocols and emergency procedures — although these requirements are rarely enforced by inspections.
The US Bureau of Labor Statistics says that the rate of recordable incidents in scientific research and development services has fallen from 2.1 per 100 full-time employees in 2003 to 1.2 in 2009. But the government does not track major accidents or near misses specifically in academic laboratories. "Anecdotally, most people agree that university labs have more frequent and more frequently serious accidents than industry," says Dorothy Zolandz, director of the National Academies Board on Chemical Sciences and Technology.
Researchers often point out that industry is in a better position than academia to keep safety standards high because it has a clear hierarchy of power, fewer inexperienced students, and accountability to management. One of the clearest difference lies in lone working: surveys by the American Chemical Society last year suggest that 70.5% of faculty and 52.1% of graduate students often or occasionally work alone in laboratories, something that is forbidden in industry.
Safety officers and experienced chemists say that good laboratory safety relies on far more than regular inspections. What's key, says Tom Welton of Imperial College London, is that the group's research leader accepts unequivocal responsibility for the safety of everyone doing science in the laboratory, building a culture where researchers instinctively have safety foremost in their minds.
Evidence presented at a US National Research Council meeting on laboratory safety in November 2010 backs up Welton's point. Ron Zanoni, manager of occupational safety at international chemicals giant Arkema, based in Colombes, France, showed a 2004 survey that found case injury rates ranging from 7.8 to 0.8 per year at Arkema's various US sites. The differences correlated well with working relationships and top-down leadership engagement at different sites, Zanoni says. Improving safety leadership at labs with poor records had reduced injury rates by 2007.
“Changing the culture is really going to be a long-term challenge.”

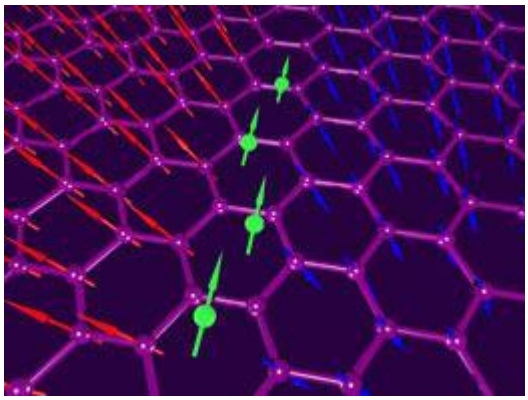
As UCLA has found, it can be hard to change researchers' mindsets, even after a death on campus. Over the past two years, the university has ramped up laboratory safety regulations, training and inspections. But Nancy Wayne, a physiology professor on the board of the new laboratory safety centre, says researchers at UCLA do not always appreciate the tougher regime, sometimes seeing environmental inspectors as 'police', rather than partners in improving standards. "Changing the culture is really going to be a long-term challenge," says Gibson. Some professors, he says, have even questioned the need for flame-resistant lab coats — a bitter irony given the circumstances of Sangji's accident.
She was using a syringe to draw reactive t-butyl lithium from a bottle when it burst into flames, setting her clothes alight. She was not wearing a lab coat. Since then, the California Division of Occupational Safety and Health has agreed fines with UCLA of around US$70,000 for safety violations. Sangji's supervisor, Patrick Harran, declined Nature 's request for an interview. The Los Angeles district attorney is still reviewing Sangji's case, and has not yet decided whether to press criminal charges against either Harran or UCLA. If this resulted in a conviction, "the rules change completely right then and there", says Langerman. "All of a sudden, if you hurt somebody badly, you may face felony charges."
In the United Kingdom, the threat of legal action has proved to be a powerful incentive for change. Around 25 years ago, an explosion in a chemistry laboratory at Sussex University in Brighton shot a piece of metal into a student's abdomen. The student eventually recovered, but the government's Health and Safety Executive prosecuted Sussex University for negligence. The episode had a profound effect on safety standards in Britain, says Welton. Today, British researchers are required to write down risk assessments before every experiment, something that is not required in the United States.

"I think that it will take a professor being punished, perhaps unfairly, to really engender change on the part of academia overall," says chemical-safety blogger Chemjobber, an industrial synthetic organic chemist in the United States. But funding agencies could also play a part. The CSB, for example, is considering recommending that grant applications should contain specific safety-training requirements.
"I think in the long run, the CSB recommendations, a possible new OSHA lab standard, and input from the American Chemical Society will result in a modification of the regulatory climate," says Langerman. But scientists should not wait for those changes before taking the initiative on safety, he adds.
"Members of the academic community have unique freedoms that are denied to industry," he says. "They then have a unique responsibility to behave in a manner that supports the freedom they are given."

http://www.nature.com/news/2011/110418/full/472270a.html

Graphene turns spin doctor

Single-atom carbon sheets could be ideal for spintronics.
Edwin Cartlidge



A flow of electrons (green arrows) magnetises graphene in the opposite directions to the left and to the right from the current flow.Science/AAAS

The ultra-thin form of carbon known as graphene has been hailed as a wonder material because of its exceptional electrical, thermal and mechanical properties. It now appears to have just the qualities needed to make ultra-fast electronic circuits that utilize the spin as well as the charge of electrons.

Graphene is a layer of carbon one atom thick arranged in a hexagonal lattice. Discovered in 2004 by Andre Geim and Konstantin Novoselov of Manchester University, UK, who used sticky tape to remove slivers of graphite from pencil lead, its enormous strength, high thermal conductivity and unique electronic properties have spawned a huge amount of both fundamental and applied research and earned its discoverers the Nobel prize in physics last year.

In the latest work, published today in Science[1], Geim and an international team of colleagues show that graphene could be used to make a new generation of so-called 'spintronic' devices. Conventional silicon chips encode binary data using the presence or absence of electric charge, but there is a limit to how small such chips can be made because of the heat generated by electrical currents. The idea of spintronics is to use not only electrons' charge but also their inherent angular momentum, or spin, which can be either 'up' or 'down'. That should yield devices that are smaller and faster, thanks to the fact that an electron's spin can be changed much more quickly than charge can flow round a circuit.

Magnetic magic

In practice, however, it is difficult to build components that can simultaneously inject, manipulate and then read out currents based on electron spin. One way to do this is to combine semiconductors with magnetic materials, with the latter injecting spin-polarized currents into the former, but finding materials that are compatible with one another is extremely tricky. It would be better if the three-step process could be carried out in a single material. Graphene appears to fit that bill.

Geim and colleagues passed an electric current between two electrodes placed about a millionth of a metre apart on a graphene sheet and then measured the voltage across a region of the sheet about ten millionths of a metre from the electrodes. In any other material, that voltage would be close to zero, because currents straying from the path between the two electrodes become progressively weaker the farther away they get. But the researchers found that when they applied a magnetic field across the graphene sheet there was in fact a significant voltage.

This, they say, is evidence of spin currents. What they believe is happening is that the magnetic field creates an imbalance in the number of spin-up and spin-down electrons, because it becomes energetically favourable for more of one type to line up with the field. Conversely, the field creates an opposite imbalance in the spin of electron vacancies, or holes. At the same time, the magnetic field exerts a force on the electrons and holes, as it would on any current flowing through a conductor, pushing them away from the current path.

Sensing spin

Team member Leonid Levitov at the Massachusetts Institute of Technology in Cambridge explains that because the electrons and holes are pushed in the same direction there is no net movement of charge, but

because both types of carrier have the same spin (as a hole can be thought of as an anti-electron) then there is a flow of spin. And, he says, just as an electric current travelling in an antenna generates an electromagnetic field that can generate a current in another antenna some distance away, so too a spin-current generated from a voltage can return the favour and induce a new voltage far from the original.
Levitov points out that their experiment does not provide direct proof that graphene can generate spin currents. But he maintains that he and his colleagues have analysed all other possible explanations and found them wanting.
The practical applications of the work could be limited, Geim admits. Having to apply a magnetic field is a disadvantage, because it means that spintronic devices made of graphene could then be sensitive to unintended sources of magnetism. But he believes that graphene could yield much stronger and longer-lasting spin currents than other materials that naturally possess a spin-charge correlation and therefore do not require a magnetic field.
David Awschalom of the University of California, Santa Barbara, who was not involved with the work, believes that the experimental results "unveil an intriguing mechanism for electrically driving spin transport in graphene". And he says that the technique "may have interesting applications within both sensing and spintronics".

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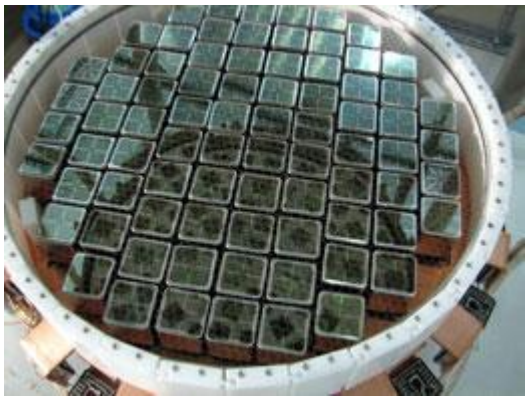
Dark matter no-show confronts supersymmetry

The XENON100 experiment has placed the tightest limits yet on the properties of dark matter.
Eugenie Samuel Reich



The XENON100 experiment did not see any dark matter particles, but it did set new limits on supersymmetry.
After months of battling radioactive contamination that threatened to swamp its detector, the XENON100 collaboration has managed to place the strongest limits yet on the detection of dark matter. The no-show, announced today at a seminar in Gran Sasso National Laboratory in Italy, places constraints on supersymmetry, the leading alternative to the standard model of particle physics.
Dark matter is thought to make up 83% of the matter in the Universe, and a number of experiments are competing to be the first to detect its rare interactions with ordinary matter. XENON100 looks for proposed dark-matter particles called weakly interacting massive particles (WIMPs) as they pass through the central portion of 161 kilograms of liquid xenon beneath 1.4 kilometres of rock at Gran Sasso. The particles should produce electric charge and light signals as they collide with xenon nuclei.
In a paper published online last night, the XENON100 researchers report three events detected during a 100-day run of the experiment last year that might have been due to dark matter[1]. However, as they expected to see between 1.2 and 2.4 background events — interactions mostly caused by a radioactive contaminant in the xenon — their result is statistically negative and therefore rules out the existence of many of the more strongly interacting and heavier WIMPs.
"We were of course hoping to see evidence of dark matter and we didn't, but we did have a very high sensitivity," says particle physicist Laura Baudis of the University of Zurich in Switzerland, and a group leader in the XENON100 collaboration. Baudis notes that contamination was higher than hoped, and higher than in a previous experimental run[2], because of a leak in the experiment. However, she says, it is still much lower than that in many other experiments, and low enough that the group can be confident in its findings.
The new findings significantly constrain supersymmetry, a theory that predicts the existence of a host of particles that physicists are hoping to detect through collisions in the Large Hadron Collider (LHC) at CERN, Europe's particle-physics lab in Geneva, Switzerland. The lightest of the particles predicted by supersymmetry may also be a WIMP.
In their paper, the XENON100 researchers report that their result is the first to cut into the region of heavier WIMPS that is also accessible by the LHC. Baudis says that it also contradicts reports of the lighter WIMPs that the Dark Matter experiment (DAMA) in Gran Sasso, and Coherent Germanium Neutrino Technology (CoGeNT) experiment in the Soudan mine in Minnesota claimed to detect.

WIMP limits

Dan Hooper, a theoretical physicist at Fermilab in Batavia, Illinois, says that he is enthusiastic about the limits the XENON100 collaboration have placed on heavier WIMPs. But he questions whether the detector is sensitive enough to lighter ones to challenge the DAMA and CoGeNT findings. "I'm a little more sceptical about that," he says.
Juan Collar, a cosmologist at the University of Chicago in Illinois, who works on CoGeNT, agrees. He says that a lot rests on the calibration of the XENON100 detector, which he will be looking to study in detail. "Previous attempts by the XENON collaboration to calibrate the response of their detector contained traceable

mistakes in methodology," he says[3]. Only if his analysis confirms the calibration would he be sure that the experiment is in conflict with the DAMA and CoGeNT results.
The previous record ruled out WIMPS that were five times more likely to interact with ordinary matter as the new results, and was set in 2010 by XENON100 and the Cryogenic Dark Matter Search (CDMS), another experiment in the Soudan mine that is looking for WIMPs hitting the nuclei of atoms in germanium crystals.

CDMS member Sunil Golwala of California Institute of Technology in Pasadena, says that XENON100's latest result is "impressive". He adds that the sudden rate of progress — improving constraints by a factor of five in just a year — is typical for this type of experiment, which is able to progress fast until its level of background becomes close to the level of the signal it is looking for. That point seems to have been reached now, so, he says, improving greatly on the current results will require the construction of larger detectors, to give WIMPS a greater mass of detector to collide with and produce a signal. The XENON100 collaboration hopes eventually to scale up to use as much as one tonne of xenon, which will be 100 times more sensitive to potential WIMPS.
Another large-scale xenon experiment expected to come online by the end of this year is the Large Underground Xenon (LUX) detector, which will search for dark matter using 350 kilograms of liquid xenon placed underground in the Sanford Underground Laboratory at Homestake, South Dakota. LUX physicist Rick Gaitskell of Brown University in Rhode Island, is upbeat about XENON100's result. "From our point of view this is very exciting because we're seeing a result from the new generation of xenon detectors that is a significant improvement over any other competing technology," he says, adding that the sensitivity of XENON100 bodes well for LUX's chances of finding dark matter — or ruling it out.

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Are languages shaped by culture or cognition?

Linguists debate whether languages share universal grammatical features.
Philip Ball

New research disputes the idea that language is rooted in the basic way in which humans think.Alamy
Languages evolve in their own idiosyncratic ways, rather than being governed by universal rules set down in human brain patterns. That is the conclusion of a study that compares the grammar of several hundred languages by looking at their evolutionary trees.
Russell Gray, a psychologist at the University of Auckland in New Zealand, and his colleagues examined the relationships between traits such as the ordering of verbs and nouns in four linguistic families, and found no sign of any persistent, universal guiding principles (See 'Universal truths'). Their work is published today by Nature[1].
It is already proving controversial. "There is nothing in the paper that brings into question the views that they are arguing against," says Matthew Dryer, a linguist at the State University of New York at Buffalo.

Fixed patterns

There are thought to be around 7,000 languages in the world today, and they show tremendous diversity in structure. Some, such as Finnish, have complex ways of making composite words, whereas others, such as Mandarin Chinese, have simple, short and invariant words. Some put verbs first in a sentence, others in the middle and yet others at the end.
But many linguists suspect that there is some universal logic behind this bewildering variety — that common cognitive factors underpin grammatical structures. US linguists Noam Chomsky and Joseph Greenberg proposed two of the most prominent 'universalist' theories of language.
Chomsky tried to account for the astonishing rapidity with which children assimilate complicated and subtle grammatical rules by supposing that we are all born with an innate capacity for language, presumably housed in brain modules specialized for language. He suggested that this makes children able to generalize the grammatical principles of their native tongue from a small set of 'generative rules' that are hardwired into how they think.
Chomsky supposed that languages change and evolve when the parameters of these rules get reset throughout a culture. A single change should induce switches in several related traits in the language.
Greenberg took a more empirical approach, listing traits that he observed to be shared between languages. Many of these concerned word order. For example, in most languages a conditional clause normally precedes its conclusion: "if he's right, he'll be famous". Greenberg argued that such universals reflect fundamental linguistic biases, which probably reflect basic principles of human cognition.

"The Greenbergian word-order universals have the strongest claim to empirical validity of any universalist claim about language," says Michael Dunn, an evolutionary linguist at the Max Planck Institute for Psycholinguistics in Nijmegen, the Netherlands, and co-author of the paper in Nature.

Shifting standards

Both of the universalist ideas have implications for the family tree of language. In Chomsky's theory, as languages evolve, certain features should vary at the same time because they are products of the same underlying parameter. Greenberg's idea, by contrast, implies that there are co-dependencies between certain grammatical features of a language, but not others. For example, the word order for verb–subject pairs shouldn't depend on that for object–verb pairs.

To test these predictions, Gray and his colleagues used phylogenetic analysis, a technique developed in evolutionary biology, to reconstruct four family trees representative of more than 2,000 languages: Austronesian, Indo-European, Bantu and Uto-Aztecan.

For each family, they looked at eight word-order features and used statistical methods to calculate the chances that each pair of features had evolved independently or in a correlated way. This allowed them to deduce webs of co-dependence among the features and compare them to the predictions of Chomsky and Greenberg's theories.

They found that neither of the universalist models matched the evidence. Not only did the co-dependencies that they discovered differ from those predicted by Greenberg's word-order 'universals', but they were different for each family. In other words, the deep grammatical structure of every family is different from that of the others: each family has evolved its own rules, so there is no reason to suppose that they are governed by universal cognitive factors.

What's more, even when a particular co-dependency of traits was shared by two families, the researchers could show that it came about in different ways for each, so it was possible that the commonality was coincidental. They conclude that the languages — at least in their word-order grammar — have been shaped in culture-specific ways rather than by universals.

A question of lineage

Martin Haspelmath, a linguist at the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany, agrees with Gray's conclusions but says that "for specialists they are nothing new". "It has long been known that grammatical properties and dependencies are lineage-specific," he adds.

On the other hand, Dryer is not persuaded that the results make a convincing case. "There are over a hundred language families that the authors ignore but which provide strong support for the views they are arguing against," he says. There is no reason to expect a consistent pattern of word-order relationships within families, he adds, regardless of whether they are shaped by universal constraints.

Haspelmath says that it might be more valuable to look for what languages have in common than to measure how they (inevitably) differ. Even if cultural evolution is the primary factor in shaping them, he says, "it would be very hard to say that cognitive biases play no role at all".

"Comparative linguists have focused on the universals and cognitive explanations because they wanted to explain something," adds Haspelmath. "Saying that cultural evolution is at play basically means that we can't explain why languages are the way they are — which is largely true, but it's not the whole truth."

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Biofuels need enforceable ethical standards

Europe's renewable energy targets have 'backfired'.
Natasha Gilbert

Stricter ethical and environmental standards are needed to balance land use for food and for biofuels.FANCY
European policies to boost biofuel use have driven an "unsustainable" and "unethical" expansion of global production, bioethicists warn in a report today.
Policies such as the European Renewable Energy Directive, through which European Union (EU) states committed in 2008 to source 10% of their transport energy needs from renewable fuels by 2020, have "backfired badly", says Joyce Tait, a science-policy expert and lead author of the study.
The rapid growth of biofuel production in some developing countries has led to deforestation, rising food prices and the displacement of indigenous people, says the report — Biofuels: Ethical Issues — released today by the Nuffield Council on Bioethics, a think-tank in London.
The report says that existing policies should be replaced by a new enforceable strategy and strict ethical and environmental standards. It suggests six principles as the basis for future biofuel policies. These include respecting people's rights to food, work and health when producing biofuels. In addition, biofuels should be environmentally sustainable, contribute to a net reduction in total greenhouse-gas emissions and adhere to fair-trade principles.

Swift sanctions

The report proposes the establishment of a compulsory scheme to certify that biofuels produced in, or imported into, the EU meet human-rights standards. It also suggests that the European Commission should set up monitoring systems to enable swift sanctions against those found to be abusing human rights.
In addition, the report calls on the United Nations Environment Programme to develop an international standard for the environmental sustainability of biofuels.
Researchers are developing types of biofuels that can be grown on less land and produce fewer greenhouse gases, but this next generation is still years away from commercial use. The report calls on policy-makers to

spur research and development in these technologies that also could reduce the effect of biofuels on food security.

If a biofuels technology meets all the proposed environmental and ethical standards, then there is a "duty" to develop it, the report says, because biofuels have the potential to help tackle climate change and provide new jobs and sources of income, especially for poor farmers in developing countries.
Richard Templer, director of the Porter Institute for Sustainable Bioenergy Research at Imperial College London, says he "can't disagree" with the ethical principles set out in the report. But he points out that the land used for biofuel production is only a fraction of that used for agriculture. "We would like to see these principles apply to all uses of land," he says.
Biofuels cannot become economically sustainable if those industries that account for the majority of land use do not also abide by the principles, Templer adds.

http://www.nature.com/news/2011/110412/full/news.2011.230.html

Hungry judges dispense rough justice

When they need a break, decision-makers gravitate towards the easy option.
Zoë Corbyn

A judge is less likely to parole a prisoner at the end of a session than at the beginning.Punchstock

A prisoner's chance of parole depends on when the judge hearing the case last took a break, say researchers who have studied decisions in Israeli courts. As judges tire and get hungry, they slip towards the easy option of denying parole, say the researchers.

The bias could apply in any situation in which people make sequential decisions, such as doctor's consultations, university admissions or grant-review panels.

Jonathan Levav of Columbia Business School in New York and his colleagues analysed 1,112 parole hearings for inmates of four Israeli prisons, made by eight judges over a ten-month period.

Judges' days were divided into three sessions broken by two meal breaks — a morning snack and lunch. Judges decided when to break, but had no control over the ordering of cases, which was determined by when a prisoner's attorney arrived.

At the beginning of a session, a prisoner had a 65% chance of being parolled, the authors found. This declined to almost zero by the end of a session, and leaped back to 65% after a break.

The severity of the crime, the time served in prison, any previous incarcerations, and the availability of rehabilitation programmes were not enough to explain the effect on the probability of parole, and the nationality or sex of a prisoner made no difference. The findings are published this week in the Proceedings of the National Academy of Sciences[1].

"The work shows the consequences of mental fatigue on really important decisions even among excellent decision-makers," says Levav. "It is really troubling and quite jarring — it looks like the law isn't exactly the law."

Easy way out

Levav thinks that decision-makers gravitate towards the easier, default option as they tire. In a judge's case, this would be to deny parole.

Whether the effect is caused by a lack of food, rest or both remains unclear. And the study draws no conclusions about the quality of the decisions made. "We can't say without a shadow of a doubt that there is a causal link here, but the data are extremely suggestive of one," says Levav.

The bias could "happen anywhere where there is sequential decision-making and some kind of status quo or default that allows people to simplify those decisions", Levav says.

"Even if the effect is half the size it appears to be it is still enormously important," says David Schkade, an expert in judges' decision-making at the University of California, San Diego. The methods used to reveal the bias are sound, he adds: "They have done the things you have to do to run it to ground."

"It is hardly the first empirical demonstration of 'extra-evidentiary bias' in judges' decisions, but it is a particularly striking one because the biasing factor is seemingly innocuous and so patently irrelevant to the case at hand," says Robert MacCoun, who studies law and public policy at the University of California, Berkeley.

But Jeffrey Rachlinski, who studies judges' decision-making at Cornell University Law School in Ithaca, New York, thinks that the finding is too neat to be plausible. He suspects that the judges might have in fact ordered their cases without the researchers' realizing it. "I would like to see something similar in another group of judges before I really believe it is a finding of general importance," he says.
But Levav says the secretary of the proceedings confirmed that the order of cases was arbitrary, and that judges did not list timing as one of the factors influencing their decisions. He now plans to look at doctors' sequential treatment of patients.

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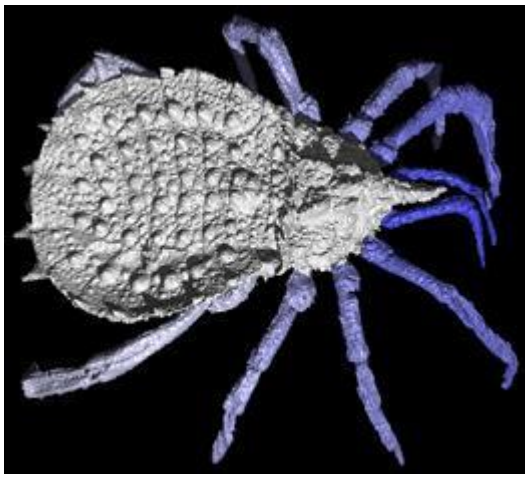
Fossil data enter the web period

Palaeontologists call for more sharing of raw information.
Ewen Callaway



Online archives can host 3D scans of fossils, such as the arachnid Eophrynus prestvicii (pictured).R. Garwood

When Ross Mounce tried to use measurements of a fossilized feathered theropod dinosaur in his research, he hit a big stumbling block. A data table in the paper describing the dinosaur contained a formatting error that prevented Mounce from working out the creature's relationship to other dinosaurs, and the paper's senior author ignored repeated e-mail requests for the original file.

Mounce, who is studying for a PhD in evolution at the University of Bath, UK, eventually got the file after the journal's editor intervened. Now Mounce is leading a campaign to avoid such situations by making it standard practice for palaeontologists to upload the raw data behind their papers into online repositories — common practice in other disciplines but rare in palaeontology. The call has drawn a mixture of support and dismay, but a sea change may already be under way: several palaeontology journals have recently rolled out digital-archiving policies that align with Mounce's goal.

Palaeontologists calling for better digital record-keeping and data sharing say that the move will not only spare scientists the trouble of tracking down information about fossils, but will also underpin future studies using the data in ways that are not possible today. "I think that is far and away the biggest plus," says Peter Wagner, curator of palaeozoic molluscs at the US National Museum of Natural History (NMNH) in Washington DC, who backs the campaign.

Public repositories already aid data sharing in other fields. Genbank, a database run by the US National Center for Biotechnology Information in Bethesda, Maryland, makes more than 100 million genetic sequences freely available, and most journals demand that scientists publishing in their pages add their data to it.

Similar databases do exist for palaeontologists. MorphoBank, for example, logs detailed fossil images, including three-dimensional computed tomography scans. Another repository, TreeBASE, collects the phylogenetic trees that show evolutionary relationships between species. But journals do not compel researchers to add their data to these systems, and Mounce — along with almost 150 signatories to an open letter — thinks that they should.

Some scientists are concerned that disclosing key data such as detailed geographical information about fossil discoveries would feed the illicit fossil trade. "The Burgess Shale is a case in point. It's a well known locality and it's pillaged to death," says Jonathan Antcliffe, a palaeobiologist at the University of Bristol, UK, referring to a rich trove of Cambrian fossils in the Canadian Rocky Mountains. Some countries, including the United States, make it illegal to publicly disclose fossil sites on public lands.

Antcliffe is also concerned that mandatory data archiving could discourage scientists from publishing progress reports on long-term projects, fearing that rivals will use the raw data to scoop them. He adds that graduate students, who might take more time than experienced palaeontologists to turn research into papers, would be especially vulnerable.

Tensions between scientists who discover new fossils and those who analyse and synthesize their finds are not new, says Mike Benton, a vertebrate palaeontologist at the University of Bristol. For example, Jack Sepkoski of the University of Chicago, Illinois, who in the 1970s and 1980s studied mass extinctions in the global fossil record, faced criticisms for repurposing other scientists' field work. But, says Benton, "if you wanted to keep it secret, you shouldn't have published it".

Whether palaeontologists are ready for mandatory digital archiving or not, the field seems to be going in that direction. Propelled in part by data-sharing edicts from funding agencies such as the US National Science Foundation, the Journal of Vertebrate Paleontology announced in January that it would require authors to post raw data files on its website (A. Berta and P. M. Barrett J. Vert. Paleontol. **31,** 1; 2011). It is also considering mandating storage in public repositories such as Morphobank. Meanwhile, the Paleontological Society in Boulder, Colorado, which publishes Paleobiology and the Journal of Paleontology, last month decided to archive data from its papers using a repository called Dryad. "My only concern is that archiving so far is an unfunded mandate," says Philip Gingerich, the society's president. "Archiving could easily consume an entire research budget."
Brian Huber, curator of planktic foraminifera at the NMNH and co-editor of the Journal of Paleontology, says that he too was wary of the costs of digital archiving, but has come around to the idea. "This is the way of the future, and the society decided we've got to lead on this instead of being too conservative."

http://www.nature.com/news/2011/110411/full/472150a.html

Immigration tracked through desert detritus

Discarded possessions reveal dangers of journey from Mexico into Arizona.
Nadia Drake

The Sonoran desert contains tonnes of the discarded belongings of undocumented migrants.A. Lichtenstein/Corbis

Every year, thousands of undocumented migrants make the dangerous crossing from Mexico to Arizona in the United States through the Sonoran Desert. One anthropologist is hoping to demystify these clandestine crossings by collecting discarded belongings and mapping rest stops, and analysing these using scientific methods.

In the United States, debate about illegal immigration is coloured by myth, misconception and a paucity of scientific data, says Jason De León, an anthropologist at the University of Michigan in Ann Arbor.

"We've talked about migration quite a bit in academia, but it's mostly sort of sociological or reliant on survey data after the fact," says De León. He estimates that around 200 people die near the border between Arizona and Mexico each year.

Just trying to do research in such an environment hints at the hazards of migration. "I've gotten out there, gotten in trouble, just borderline about to have sunstroke or something like that. You get a sense of how difficult it is," he says.

Since 2008, he has analysed around 100 sites used by migrants for rest stops in a roughly 50-kilometre stretch of desert between Nogales, Mexico, and Arivaca in Arizona. Working with students, he maps each site, notes what it was used for - whether people have made beds, for example - and records all the discarded objects. He has collected more than 6 tonnes of items, including backpacks, shoes, first-aid kits, clothes and water bottles.

Such artefacts help De León identify trends in migration and estimate the number of people making the journey. The presence of women's and children's shoes, for example, shows that it's not just adult men crossing the desert.

Nearer to Arivaca, sites become larger and clothing and backpacks replace food packaging in the litter. "Their guide will say, 'Ok now you gotta clean up. You look like you've just walked through the desert.' So you change your clothes, brush your teeth, wash your face - that's when you get a lot of this stuff left behind," De

León explains. He presented his findings at the Society for American Archaeology's annual meeting in Sacramento, California, on 1 April.

Blood, sweat and tears

De León has also spent months in a migrant shelter in the Mexican border town of Nogales, interviewing those about to begin the journey through the desert and those recently deported back to Mexico.

In total, his data show that migrants circumvent stricter border controls — such as increased patrols or fences — by using routes that are more remote and dangerous. "Enforcement strategies that create suffering and death are clearly no match for the hunger and poverty that drive migrants to the United States," he says.

"This is a groundbreaking type of research. De León is pushing the archaeological envelope," says archaeologist Ran Boytner of the University of Southern California in Los Angeles. "His research will have a very strong impact, both in and out of the discipline. It takes a lot of guts to do what he's doing."

De León now anticipates expanding his survey areas in Arizona, and possibly including sites in California, Texas and New Mexico.

Studying these objects humanizes undocumented migration, says José Antonio Lucero, a political scientist at the University of Washington in Seattle. Most people don't understand what drives a person to leave his or her home and embark on a risky journey.

"Jason can say a lot about the whole experience through the artefacts and the folks he meets," he says. "It's a world that we don't know very well. I hope the project leads to a more enlightened conversation about immigration."

http://www.nature.com/news/2011/110411/full/news.2011.225.html

Virgin Oceanic plumbs the depths for science

Mission scientists discuss what Richard Branson's deep-sea quest hopes to find.
Daniel Cressey

Scientists are along for the ride as Virgin Oceanic explores the deepest parts of our oceans.Virgin Oceanic Richard Branson's plans to pilot a deep-diving submarine to the bottom of the ocean may sound like just the latest adventure for the entrepreneur behind the Virgin brand. But the Virgin Oceanic mission, unveiled this week, is backed by a team of scientists planning groundbreaking marine research.

The project aims to take a one-person submarine to the deepest parts of the seas, starting with the Mariana Trench in the Pacific Ocean. This will be the first manned exploration of the area since the Trieste submersible set an unequalled depth record of more than 10 kilometres by voyaging to the bottom of the Challenger Deep region of the trench in 1960.

As well as the manned submarine, a series of remote probes will be dispatched into the depths carrying scientific equipment. Nature spoke to research-team members Douglas Bartlett, a marine microbiologist at the Scripps Institution of Oceanography in La Jolla, California, and Katrina Edwards, a microbiologist at the University of Southern California, Los Angeles, about what they hope to learn.

What excites you about this project?

DB: I was surprised to hear about this manned expedition, but certainly delighted. The dream that Chris Welsh [Virgin Oceanic's chief pilot] had was: wouldn't it be wonderful if there could be some substantial science to go along with this?

When the Trieste set down on the sea floor of the Challenger Deep area, it was there for just 20 minutes and made only very, very preliminary observations before it had to get back up to the surface. I think there's a lot of potential in using manned submersibles for exploration, in conjunction with autonomous underwater vehicles and remote-operated vehicles.

What will you get out of this?

DB: It's not difficult to get things down deep, it's just hard to get them back up. The wonderful development that has taken place over the past few years is in the use of highly pressure-resistant glass spheres. We use these to provide buoyancy to devices and to avoid tethering them to ships. The engineer that I work with — Kevin Hardy — likes to think about these untethered instruments as the pickup trucks of the deep ocean. You can hook up all sorts of things to them.

We'll get water, we'll get sediments, we might be able to put a filtration system down near the sea floor so that we can concentrate the microbes in the sea water. We can get the equivalent of perhaps thousands of litres of seawater microbes by doing that.

KE: My own organization's main contribution is more along the lines of helping them to gather physical data concerning videography, still images and bathometric data on the geology and geochemistry of the trench environments.

That's where the data are limited. We don't have much physical information at all about these really remote environments. Putting together a comprehensive set of hypotheses about what exactly is going on down there in terms of the geology, the geochemistry and in particular the microbiology, is really untrodden ground for the most part.

What devices other than the Virgin submarine will be involved in this project?

DB: The submarine will be very valuable in mapping out the environment. It can help to set the stage for future scientific missions. If that sub is out there discovering cold seeps and mud volcanoes and new areas where there are clam fields and microbial mats and who knows what, that will pique the interest of various marine biologists and geologists. In terms of actually getting material to study in a detailed way, the bulk of that is going to be from the water samples and the sediment samples and the traps.

KE: I'm hoping to get some microbiology samples back, mainly through the landers. But any information that they gain from the sub about the physical layout of what's down there can be used to develop projects that can be sold more readily to our national funding agencies. They want to know that scientists know what they're going for, and they don't want to go on fishing expeditions. For remote environments, we have so little information that it's nearly impossible to put proposals through any national or international organization to go and collect samples. The information that we gain could be a key driving force in such efforts down the road.

How will the samples actually inform your research?

KE: My personal interests are in the part that microbes play in geological processes. For example, the Mariana Trench has a series of mud volcanoes that are the result of important reactions occurring down in the crust. Understanding what role the microbes have in those types of reaction is key in my world.

DB: We will be able to isolate single microbial cells and elucidate their genome sequences. There are high-throughput methods now for culturing microbes that will allow us to characterize them for their potential biotechnological value. There's never been a better time to explore this environment, because we can do it in much more detail than people have been able to even think about before.

http://www.nature.com/news/2011/110408/full/news.2011.224.html

Cleaner, greener fireworks

Boron carbide could light way to less-toxic green pyrotechnics.

James Mitchell Crow

Displays like this could soon be greener while being just as green.NICK FIELDING / Alamy

Call it a flash of inspiration. A US Army team of pyrotechnics experts has discovered that a compound long dismissed as inert could replace the toxic metal currently used in green-coloured fireworks.

Chemist Jesse Sabatini and his colleagues at Picatinny Arsenal in New Jersey, found that boron carbide matches the green-light-emitting performance of the barium-based compounds used in today's fireworks. Replacing the barium with boron would cut the amount of toxic material released by fireworks. This is particularly important in places where displays take place every day, such as at theme parks, where the compounds can accumulate. However, it is army personnel who look set to benefit the most from the discovery. Pyrotechnics are used heavily by the military, in signal flares on the battlefield as well as on the training ground to simulate the explosions and gunfire of combat.

"In the military world, where you use large amounts of pyrotechnics every day, it [barium exposure] becomes a real issue," says Thomas Klapötke, who researches clean pyrotechnics at the University of Munich in Germany and was not involved in the new study.

Burn boron, burn

Sabatini was tasked by the US Army with coming up with a cost-effective, barium-free alternative to the green-light-emitting hand-held M125A1 signal flare. These flares are based on a combination of barium nitrate and polyvinyl chloride (PVC) which burn to form barium chloride and emit green light. Aside from the toxicity of the barium, burning PVC has its own environmental issues, because it releases toxic polychlorinated biphenyls.

For a barium- and chlorine-free replacement, the team looked to boron. As the powdery form of the element combusts, it forms boron oxide and releases green light. Unfortunately it burns so fast that the green light is lost too quickly to be of use.

Sabatini, along with his colleagues Jay Poret and Russell Broad, found they were able to extend the burn time by adding crystalline boron into the mixture. But crystalline boron is expensive.

"It seemed that we were on the edge of a breakthrough, so we decided to look up 'exotic' boron compounds," says Sabatini. "We saw some really classic chemistry papers from back in the 1950s and '60s, which said that even though boron carbide is quite unreactive at room temperature, at high temperatures it's actually reactive."

Adding increasing amounts of boron carbide to amorphous boron successfully extended the burn time, the team reports in Angewandte Chemie[1]. Eventually they decided to try it pure and were "very surprised when it ignited", Sabatini says. Pure boron carbide proved to have the best burn time of all.

Getting the green light

Klapötke is also surprised by the performance of boron carbide. "It is thermally very stable — chemists would say it is dead, it doesn't do anything. And so I guess nobody ever tried to use it this way," he says.

Boron carbide looks like a viable replacement for barium nitrate, Klapötke adds, because it ticks all the pyrotechnic boxes with long burn times, reasonable spectral purity, and high luminous intensity. It is also

used in the real world as an industrial abrasive so there are fewer hurdles in terms of toxicity and environmental data to adopting it. Perhaps most importantly, boron carbide has a cheap price — cheaper than barium nitrate — and ready availability.
For the commercial fireworks industry as well as the military, cost is crucial to adopting new pyrotechnic formulations, says Martin Van Tiel, who runs Van Tiel Pyrotechnics, a fireworks company based in Waikato in New Zealand.
"For anything new, cost and performance are the key — if it costs twice as much no-one is going to be interested," Van Tiel says. "Throughout the history of fireworks there's been continual development — people will be quite happy to try it. The fireworks industry can be quite quick."

http://www.nature.com/news/2011/110408/full/news.2011.222.html

Chaos promotes stereotyping

A disorderly environment makes people more inclined to put others in boxes.

Philip Ball

Study subjects sat further away from someone of another race when the train station was a mess.Siegwart Lindenberg

The idea that neglected environments encourage crime and antisocial behaviour has been around since the 1980s. Now, a study shows that messy surroundings also make people more likely to stereotype others.

Diederik Stapel and Siegwart Lindenberg, social scientists at Tilburg University in the Netherlands, asked subjects in messy or orderly everyday environments (a street and a railway station) to complete questionnaires that probed their judgements about certain social groups. They found small but significant and systematic differences in the responses: there was more stereotyping in the disorderly areas than the clean ones.

The researchers suggest that local authorities could therefore counteract social discrimination by diagnosing and removing signs of disorder and decay in public environments. They report their findings today in Science[1].

David Schneider, a psychologist at Rice University in Houston, Texas, and a specialist in stereotyping, calls the study "an excellent piece of work that not only speaks to a possibly important environmental cause, but also supports a major potential theoretical explanation for some forms of prejudice".

Zero tolerance

Social scientists and criminologists have long suspected that environment has an influence on behaviour. The 'broken windows' hypothesis, developed by sociologists James Wilson and George Kelling, supposes that people are most likely to commit criminal and antisocial acts when they see evidence that others have already done so — for example, when they are in public places that show signs of decay and neglect.

This idea motivated the New York subway system's famous zero-tolerance policy on graffiti in the late 1980s (for which Kelling acted as a consultant), which is credited with improving the safety of the network.

Lindenberg and his coworkers tested the hypothesis in 2008 with a study in Dutch urban settings; their findings suggested that surroundings do have an influence on people's readiness to act unlawfully or antisocially[2].

But could evidence of social decay, even at the mild level of littering, also affect our unconscious discriminatory attitudes towards other people? To test that possibility, Stapel and Lindenberg devised a variety of disorderly environments in which to test people's mind-sets.
In one experiment, passers-by in the busy Utrecht railway station were asked to sit in a row of chairs and answer a questionnaire for the reward of a chocolate bar or an apple. The researchers took advantage of a cleaners' strike that had left the station dirty and litter-strewn to create their messy environment; they returned to do the same testing once the strike was over and the station was clean.
In the questionnaires, participants were asked to rate how much certain social groups — Muslims, homosexuals and Dutch people — conformed to qualities that formed part of positive and negative stereotypes, as well as qualities unrelated to stereotypes. For example, the 'positive' stereotypes for homosexuals were (creative, sweet), the 'negative' were (strange, feminine) and the neutral terms were (impatient, intelligent).
As well as probing these responses, the experiment examined unconscious negative responses to race. All the subjects were white, but when they were asked to sit down, one chair at the end of the row was already occupied by a black or white Dutch person. In the messy station, people sat on average further from the black person than the white one, whereas in the clean station there was no statistical difference.
To eliminate effects caused by differences in the environments' cleanliness while preserving the disorder, the researchers ran a second experiment. Subjects were approached on a street in an affluent Dutch city; in one case, the street was orderly, but in the other the same street had been made more disorderly by the removal of a few paving slabs and the addition of a badly parked car and an 'abandoned' bicycle. Again, disorder boosted stereotyping.

Imposing order

Stapel and Lindenberg say that stereotyping may be an attempt to mentally compensate for mess: "a way to cope with chaos, a mental cleaning device" that partitions other people neatly into predefined categories.
In support of that idea, they showed participants in a lab pictures of disorderly and orderly situations, such as a bookcase with either dishevelled or regularly stacked books, before asking them to complete both the stereotyping survey and another one that probed their perceived need for structure by asking them to rate the truthfulness of statements such as, "I do not like situations that are uncertain". Both stereotyping and the need for structure were higher in people viewing the disorderly pictures.
Robert Sampson, a sociologist at Harvard University in Cambridge, Massachusetts, says that the study is "clever and well done", but is cautious about how to interpret the results. "Disorder is not necessarily chaotic", he says, "and is subject to different social meanings in ongoing or non-manipulated environments. There are considerable subjective variations within the same residential environment on how disorder is rated — the social context matters."

He adds, "Once we get out of the lab or temporarily induced settings and consider the everyday contexts in which people live and interact, we cannot simply assume that interventions to clean up disorder will have invariant effects."
Schneider agrees that the implications of the work for public policy are not yet clear. "One question we'd need to answer is how long these kinds of effects last," he says. "There is a possibility that people may quickly adapt to disorder. So I would be very wary of concluding that people who live in unclean and disordered areas are more prejudiced because of that."
Stapel acknowledges this. "People who constantly live in disorder get used to it and will not show the effects we find," he says. "Disorder in our definition is something that is unexpected."

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http://www.nature.com/news/2011/110407/full/news.2011.217.html

Antibiotic resistance shows up in India's drinking water

Discovery of NDM-1 outside hospital environment raises alarm.
Naomi Lubick

Antibiotic resistance genes have been found in bacteria in drinking water and sewage, far the hospitals the usually haunt.Gurinder Osan / AP Photo

Bacteria carrying a gene that confers resistance to a major class of antibiotics have shown up in samples of drinking water and sewage seepage from New Delhi, researchers report in The Lancet Infectious Diseases today[1]. This raises the danger that people will be exposed to disease-causing bacteria that cannot be treated by antibiotics.

The resistance is bestowed by a gene, bla_{NDM-1}, that encodes the enzyme New Delhi metallo-β-lactamase 1 (NDM-1). These genes can be passed easily between bacteria by discrete rings of DNA called plasmids. The enzyme blocks the activity of a range of antibiotics including the carbapenems — drugs of last resort for resistant infections — which might be used to treat, for example, urinary-tract infections triggered by the bacterium Escherichia coli or lung infections resulting from Klebsiella pneumoniae. NDM-1-positive strains of both species have previously been found in hospitals in India and Pakistan.

NDM-1-positive bacteria have already turned up in the United Kingdom and elsewhere in patients, some of whom had previously been in hospitals in India and Pakistan[2], but this is the first report to find NDM-1 in environmental samples unconnected to hospitals or infected patients.

Last year, Timothy Walsh at Cardiff University, UK, and his colleagues pinpointed the origins of the first NDM-1-positive strain to appear in the United Kingdom. Today's paper details their examination of environments outside hospital settings, intended to provide a feel for the spread of this resistance gene across New Delhi, a city with 21 million inhabitants. The researchers asked a Channel 4 reporter and his colleagues to collect samples of tap water from homes, and human waste seeping from New Delhi's sewage systems.

Spreading out

Of 50 tap-water samples, two tested positive for NDM-1, as did 51 of the 171 sewage seepage samples. In a subset of those samples, the researchers found 11 bacterial species harbouring bla_{NDM-1} that had not previously been known to carry it — adding to the known resistant strains of E. coli and Klebsiella.

One of the strains is a Shigella bacterium, which causes dysentery, particularly in children in developing countries. "The isolate we found and analysed is resistant to all antibiotics" that might treat it, says Walsh. "Our data would suggest that possibly about 10% of the people in New Delhi carry NDM-1 in normal flora" in their guts, Walsh continues. If those native gut flora end up passing on resistance to harmful strains of E. coli, for example, that could lead to infections, such as cystitis, with "virtually no drugs that can treat it," he says.

Monsoon movement

The team's lab experiments show that the transfer rate of NDM-1-positive plasmids between microorganisms is most efficient at 30ºC, which, in real-world settings, might correspond to the monsoon season – when heavy rains could cause seepage pools to spread, increasing city residents' possibility of exposure to any pathogenic microbes that pick up the antibiotic-resistance gene.

The discovery of the gene and NDM-1-carriers in tap and waste waters is not a surprise, considering previous detections reported for hospital waste water, comments Ashok Tamhankar, the national coordinator for the Indian Initiative for Management of Antibiotic Resistance. "But to what extent this situation is going to cause damage is not yet clearly scientifically established," he adds. He also suggests that city dwellers may have already developed immunity to the organisms carrying NDM-1.

In a televised news conference from New Delhi today, Vishvamohan Katoch, secretary for the department of health research, refuted the findings. "The Lancet study is unsupported by any clinical or epidemiological evidence and does not highlight the unstable character of the isolates," he said.

Walsh and colleagues' report coincides with the World Health Day focused on antibiotic resistance and how to prevent its spread spearheaded by the World Health Organization (WHO). The last WHO report on the issue, in 2000, encouraged national surveillance, transparency and international collaboration, although some critics say not much movement has been made globally.

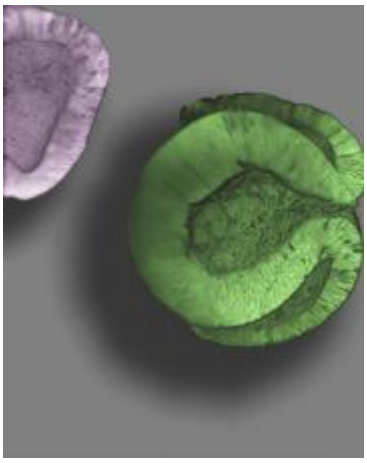
"We are keen to work with the WHO centre in India to look at carriage of this in India," Walsh says. "In terms of resistance, the part of the iceberg that's important is what we don't see in hospitals — and, in India, that part is absolutely massive."

Additional reporting by KS Jayaraman

http://www.nature.com/news/2011/110407/full/news.2011.218.html

Stem cells make 'retina in a dish'

Mouse cells have been coaxed into forming a retina, the most complex tissue yet engineered.
Ewen Callaway



Here's lookin' at you kid.M. Eiraku and Y.Sasai at RIKEN Center for Developmental Biology

A retina made in a laboratory in Japan could pave the way for treatments for human eye diseases, including some forms of blindness.

Created by coaxing mouse embryonic stem cells into a precise three-dimensional assembly, the 'retina in a dish' is by far and away the most complex biological tissue engineered yet, scientists say.

"There's nothing like it," says Robin Ali, a human molecular geneticist at the Institute of Ophthalmology in London who was not involved in the study. "When I received the manuscript, I was stunned, I really was. I never though I'd see the day where you have recapitulation of development in a dish."

If the technique, published today in Nature[1], can be adapted to human cells and proved safe for transplantation — which will take years — it could offer an unlimited well of tissue to replace damaged retinas. More immediately, the synthetic retinal tissue could help scientists in the study of eye disease and in identifying therapies.

The work may also guide the assembly of other organs and tissues, says Bruce Conklin, a stem-cell biologist at the Gladstone Institute of Cardiovascular Disease in San Francisco, who was not involved in the work. "I think it really reveals a larger discovery that's coming upon all of us: that these cells have instructions that allow them to self-organize."

Cocktail recipe

In hindsight, previous work had suggested that, given the right cues, stem cells could form eye tissue spontaneously, Ali says. A cocktail of genes is enough to induce frog embryos to form form eyes on other parts of their body[2], and human embryonic stem cells in a Petri dish can be coaxed into making the pigmented cells that support the retina, sheets of cells that resemble lenses and light-sensing retinal cells themselves[3].

However, the eye structure created by Yoshiki Sasai at the RIKEN Center for Developmental Biology in Kobe and his team is much more complex.

The optic cup is brandy-snifter-shaped organ that has two distinct cell layers. The outer layer — that nearest to the brain — is made up of pigmented retinal cells that provide nutrients and support the retina. The inner layer is the retina itself, and contains several types of light-sensitive neuron, ganglion cells that conduct light information to the brain, and supporting glial cells.

To make this organ in a dish, Sasai's team grew mouse embryonic stem cells in a nutrient soup containing proteins that pushed stem cells to transform into retinal cells. The team also added a protein gel to support the cells. "It's a bandage to the tissue. Without that, cells tend to fall apart," Sasai says.

At first, the stem cells formed blobs of early retinal cells. Then, over the next week, the blobs grew and began to form a structure, seen early in eye development, called an optic vesicle. Just as it would in an embryo, the laboratory-made optic vesicle folded in on itself over the next two days to form an optic cup, with its characteristic brandy-snifter shape, double layer and the appropriate cells.

Even though the optic cups look and develop like the real thing, "there may be differences between the synthetic retina and what happens normally," Ali says.
Sasai's team has not yet tested whether the optic cups can sense light or transmit impulses to the mouse brain. "That's what we are now trying," he says. However, previous studies have suggested that embryonic retinas can be transplanted into adult rodents[4], so Sasai is hopeful.
Sasai, Ali and others expect that human retinas, which develop similarly to those of mice, could eventually be created in the lab. "In terms of regenerative medicine, we have to go beyond mouse cells. We have to make human retinal tissue from human embryonic stem cells and investigation is under way," Sasai says.

The eyes have it

Synthetic human retinas could provide a source of cells to treat conditions such as retinitis pigmentosa, in which the retina's light-sensing cells atrophy, eventually leading to blindness. In 2006, Ali's team found that retinal cells from newborn mice work when transplanted into older mice[5]. Synthetic retinas, he says, "provide a much more attractive, more practical source of cells".
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David Gamm, a stem-cell biologist at the University of Wisconsin, Madison, says that transplanting entire layers of eye tissue, rather than individual retinal cells, could help people with widespread retinal damage. But, he adds, diseases such as late-stage glaucoma, in which the wiring between the retina and brain is damaged, will be much tougher to fix.
When and whether such therapies will make it to patients is impossible to predict. However, in the nearer term, synthetic retinas will be useful for unpicking the molecular defects behind eye diseases, and finding treatments for them, Sasai says. Retinas created from reprogrammed stem cells from patients with eye diseases could, for instance, be used to screen drugs or test gene therapies, Ali says.
Robert Lanza, chief scientific officer of the biotechnology company Advanced Cell Technology, based in Santa Monica, California, says the paper has implications far beyond treating and modelling eye diseases. The research shows that embryonic stem cells, given the right physical and chemical surroundings, can spontaneously transform into intricate tissues. "Stem cells are smart," Lanza says. "This is just the tip of the iceberg. Hopefully it's the beginning of an important new phase of stem-cell research."

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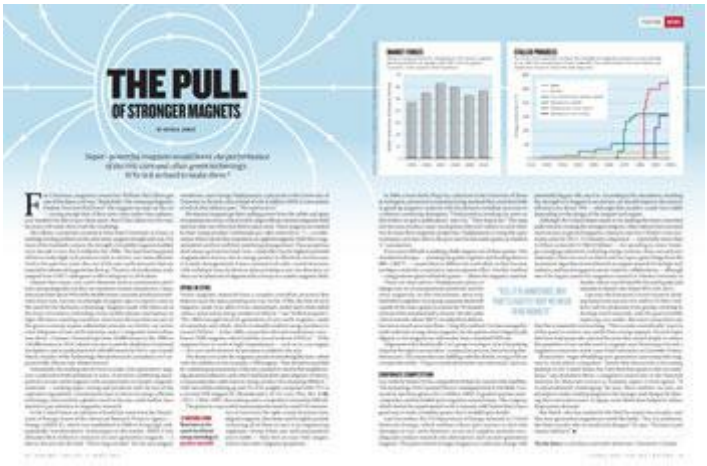
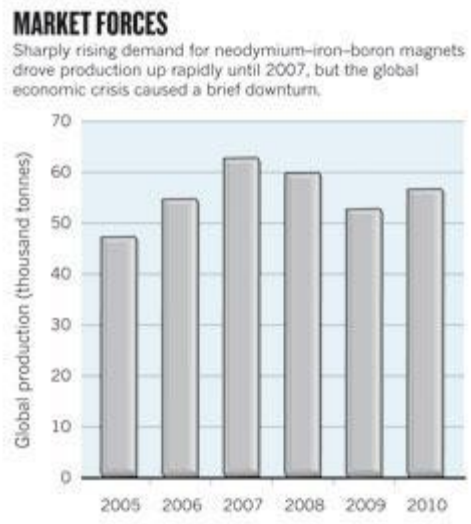
The pull of stronger magnets

Super-powerful magnets would boost the performance of electric cars and other green technology. Why is it so hard to make them?
Nicola Jones



For Christmas, magnetics researcher William McCallum got one of the latest cool toys: 'Buckyballs: The Amazing Magnetic Desktoy You Can't Put Down!' The magnets are state-of-the-art — strong enough that, if they were cubes rather than spheres, you wouldn't be able to pry them apart. But if McCallum has his way, his team will make them look like weaklings.
McCallum, a materials scientist at Iowa State University in Ames, is tackling two big problems at the same time: magnet strength and cost. For most of the twentieth century, the strength of available magnets doubled every decade or two, but it stalled in the 1990s. The limit has hampered efforts to make high-tech products such as electric cars more efficient. And in the past two years, the cost of the rare-earth elements that are essential to advanced magnets has shot up. The price of neodymium oxide jumped from US$17 a kilogram to $85 a kilogram in 2010 alone.
Despite their name, rare-earth elements such as neodymium aren't truly rare geologically, but they are expensive to mine and process. China, which provides about 95% of the 96,000 tonnes currently produced worldwide every year, has put increasingly stringent caps on exports, even as the need for the elements is booming. Magnets made with them are at the heart of modern technology from mobile phones and laptops to high-efficiency washing machines. And many devices that are part of the green economy require substantial amounts: an electric car carries a few kilograms of rare-earth elements, and a 3-megawatt wind turbine uses about 1.5 tonnes. Demand leapt from 30,000 tonnes in the 1980s to 120,000 tonnes in 2010 (which was met in part by depletion of national stockpiles), and is predicted to hit 200,000 tonnes by 2015, says Gareth Hatch, founder of the Technology Metals Research consultancy in Carpentersville, Illinois (see 'Market forces').

Fortunately, the leading idea for how to make 'next-generation' magnets could solve both problems at once. It involves combining nanoparticles of rare-earth magnets with nanoparticles of cheaper magnetic materials — creating super-strong end-products with far less of the expensive ingredients. Governments keen to invest in energy-efficient technology, and scared by a global crunch in the rare-earth market, have started to pay attention to magnetics research.
In the United States, an infusion of funds has come from the Department of Energy, home of the Advanced Research Projects Agency — Energy (ARPA-E), which was established in 2009 to bring high-risk, potentially 'transformative' technologies to the market. ARPA-E has allocated $6.6 million to research on next-generation magnets — a shot in the arm for the field. "We're long overdue" for the next magnet revolution, says George Hadjipanayis, a physicist at the University of Delaware in Newark, who is head of a $4.4-million ARPA-E consortium of which McCallum is part. "We need to do it."



Permanent magnets get their pulling power from the orbits and spins of unpaired electrons, which tend to align with an external magnetic field and stay that way when that field is taken away. These magnets are ranked by their 'energy product' in kilojoules per cubic metre (kJ m^{-3}) — a combination of how much they respond to an applied magnetic field (their magnetization) and how well they resist being demagnetized. These properties don't always go hand in hand. Iron–cobalt alloy has the highest potential magnetization known, but its energy product is effectively zero because it is easily demagnetized: it has a symmetrical cubic crystal structure, with nothing to keep its electron spins pointing in any one direction, so they can be jolted out of alignment by a bump or a nearby magnetic field.

Spins in sync

Newer magnetic materials have a complex crystalline structure that helps to keep the spins pointing one way. In the 1950s, the best of such magnets, made of an alloy of iron, aluminium, nickel and cobalt called Alnico, achieved an energy product of 40 kJm^{-3} (see 'Stalled progress'). The 1960s brought the first generation of rare-earth magnets, made of samarium and cobalt, which eventually enabled energy products to exceed 250 kJm^{-3}. In the 1980s, researchers devised neodymium–iron–boron (NIB) magnets, which hold the record at about 470 kJm^{-3}. If the magnets have to work at high temperatures — such as in a car engine — the rare-earth element dysprosium is added to the mix.

The dream is to unite the magnetic punch of something like iron–cobalt with the stability of, for example, a NIB magnet. That should be possible by combining nanoparticles of the two, packed so closely that neighbouring electrons influence each other and keep their spins aligned. In theory, a nanocomposite could reach an energy product of a whopping 960 kJm^{-3}, with rare earths making up just 5% of its weight, compared with 27% in a normal NIB magnet (R. Skomski and J. M. D. Coey Phys. Rev. B **48,** 15812–15816; 1993). But making such a composite is extremely difficult.

The grains in a successful nanocomposite must be small (10 nanometres or less); have the right crystal structure; have aligned magnetic directions; and be tightly packed. Achieving all of these at once is an engineering nightmare. On top of that, rare-earth nanoparticles aren't stable — they love to react with oxygen, which ruins their magnetic properties.

In 2006, a team led by Ping Liu, a physicist at the University of Texas at Arlington, pioneered a manufacturing method that used steel balls to grind up magnetic material with the desired crystalline structure in a solution containing detergents. "I had postdocs working for years on this before we got a publication," says Liu. "They hated me." The soap lets the team produce nano-sized grains that don't adhere to each other but do keep their magnetic properties. Hadjipanayis is using the same technique, and says that in the past year he has made grains as small as 2.7 nanometres.

Even more difficult is making a bulk magnet out of these grains. One standard technique — pressing the grains together and heating them to 800–1,000°C — causes them to diffuse into each other, so they become too big to create the cooperative nanocomposite effect. Another method — using polymer glues to bind the grains — dilutes the magnetic material.

There are alternatives. Hadjipanayis plans to charge one set of nanoparticles positively and the other negatively, so that electrostatic attraction binds them together. Liu's group squeezes about half a gram of the nano-grains in a press for 30 minutes instead of the standard half a minute. He also adds a bit of warmth (about 500°C) to help them deform, but not so much as to ruin them. Using this method, Liu has managed to make relatively strong, dense magnets, but the grains aren't magnetically aligned, so the magnets are still weaker than a standard NIB one.

Alignment is the final hurdle. Liu's group is trying to clear it by putting material through a second slow-compaction process, but is having limited success. The researchers are fiddling with the details, trying to hit on a recipe that works. "I hope it can be done before my retirement," says Liu.

Corporate competition

Liu could be beaten by his competition before he reaches that deadline. The technology firm General Electric, headquartered in Fairfield, Connecticut, has been given a $2.2-million ARPA-E grant to pursue nanocomposites, and has beefed up its magnetics research team. The company, which started its experimental work in January, told Nature that it has a good way to make crystalline grains, but it wouldn't give details. “Yes, it is ambitious, but that's exactly why we need to be doing it.”

Last December, the US Department of Energy released its Critical Materials Strategy, which outlines a three-part mission to deal with shortages in rare-earth elements: secure new supplies, promote recycling and conduct research into alternatives, such as next-generation magnets. This push toward stronger magnets is a welcome change with potentially big pay-offs, says Liu. According to his calculations, doubling the strength of a magnet in an electric car should improve the motor's efficiency by about 70% — although that number could vary wildly depending on the design of the magnet and engine.

Although the United States seems to be making the most concerted push towards creating the strongest magnets, other nations have invested more money in general magnetics research, says Liu. China's 5-year economic plan for 2011–15 includes a big boost — reportedly more than 4 trillion renminbi (US$610 billion) — for spending in seven 'strategic emerging industries', including energy systems, clean cars and new materials. Observers such as Hatch and Liu expect great things from the investment. Japan has invested heavily in magnet research for its high-tech industry, and has strong government–industry collaborations — although one of its largest centres for magnetics research is Tohoku University in Sendai, which was hit hard by the earthquake and tsunami in March (see Nature **471,** 420; 2011).

Last year, the European Union's research-funding framework put out a €4-million (US$6.3-million) call for proposals from groups working to develop novel materials, with the goal of totally replacing rare earths. But most researchers say that this is massively overreaching. "This is a joke, scientifically," says Liu of the quest to remove rare earths from strong magnets. Several major labs have had proposals rejected because they aimed simply to reduce the quantities of rare earths used in magnets, says Dominique Givord, a magnetics researcher at the Louis Néel Laboratory in Grenoble, France.

Researchers' target of building next-generation nanocomposite magnets is, most admit, a long shot. "I know that this activity is becoming popular in the United States, but I feel that their goal is a bit too ambitious," says Kazuhiro Hono, a magnetics researcher at the National Institute for Materials Science in Tsukuba, Japan.
Givord agrees. "It is extraordinarily challenging," he says. More realistic, he says, are attempts to make existing magnets a bit stronger and cheaper by altering their microstructures. In Japan, such efforts have helped to reduce dysprosium demand.
But Hatch, who has worked in the field for nearly two decades, says that next-generation magnets are worth the battle. "Yes, it is ambitious, but that's exactly why we need to be doing it," he says. "It's time to put money behind it."
Nicola Jones is a freelance journalist based near Vancouver, Canada

http://www.nature.com/news/2011/110406/full/472022a.html

World-Wide Assessment Determines Differences in Cultures

Ukraine, Israel, Brazil and the United States are "loose" cultures

Population density helps determine whether a country is tight or loose as this German street hints.
Credit and Larger Version

May 26, 2011

View a webcast with University of Maryland Psychology Professor Michele Gelfand.

Conflicts and misunderstandings frequently arise between individuals from different cultures. But what makes cultures different; what makes one more restrictive and another less so?

A new international study led by the University of Maryland and supported by the National Science Foundation's Division of Behavioral and Cognitive Sciences offers insights that may help explain such cultural differences and bridge the gaps between them.

Published in the May 27 issue of the journal *Science*, the study for the first time assesses the degree to which countries are restrictive versus permissive and it all comes down to factors that shape societal norms.

The researchers found a wide variation in the degree to which various societies impose social norms, enforce conformity and punish anti-social behavior. They also found the more threats experienced by a society, the more likely the society is to be restrictive, the authors say.

"There is less public dissent in tight cultures," said University of Maryland Psychology Professor Michele Gelfand, who led the study. "Tight societies require much stronger norms and are much less tolerant of behavior that violates norms."

"Tight" refers to nations that have strong social norms and low tolerance for deviation from those norms, whereas another term, "loose," refers to nations with weak social norms and a high tolerance for deviation from them.

Gelfand and colleagues found that countries such as Japan, Korea, Singapore and Pakistan are much tighter whereas countries such as the Ukraine, Israel, Brazil and the United States are looser.

"Is important, within our view, to be mindful that we don't think that either culture is worse or better," said Gelfand.

She and her colleagues examined cultural variation in both types of societies.

"We believe this knowledge about how tight or loose a country is and why it is that way can foster greater cross-cultural tolerance and understanding," said Gelfand. "Such understanding is critical in a world where both global interdependence and global threats are increasing."

The researchers surveyed 6,823 respondents in 33 nations. In each nation, individuals from a wide range of occupations, as well as university students, were included. Data on environmental and historical threats and on societal institutions were collected from numerous established databases. Historical data--population density in 1500, history of conflict over the last hundred years, historical prevalence of disease outbreaks--were included whenever possible, and data on a wide range of societal institutions, including government, media and criminal justice, were obtained.

"You can see tightness reflected in the response in Japan to the natural disasters recently," said Gelfand referring to the massive earthquake and tsunami that hit the country on March 11 of this year.

"The order and social coordination after the event, we believe, is a function of the tightness of the society," Gelfand said, noting that tightness is needed in Japan to face these kinds of ecological vulnerabilities.

The research further showed that a nation's tightness or looseness is in part determined by the environmental and human factors that have shaped a nation's history--including wars, natural disasters, disease outbreaks, population density and scarcity of natural resources.

Tight and loose societies also vary in their institutions, with tight societies having more autocratic governments, more closed media and criminal justice systems that have more monitoring and greater deterrence of crime as compared to loose societies.

The study found that the situations that people encounter differ in tight and loose societies. For example, everyday situations--like being in a park, a classroom, the movies, a bus, at job interviews, restaurants and even one's bedroom--constrain behavior much more in tight societies and afford a wider range of behavior in loose societies.

"We also found that the psychological makeup of individual citizens varies in tight and loose societies," Gelfand said. "For example, individuals in tight societies are more prevention focused, have higher self-regulation strength and have higher needs for order and self-monitoring abilities than individuals in loose societies."

These attributes, Gelfand said, help people to adapt to the level of constraint, or latitude, in their cultural context, and at the same time, reinforce it.

The research team combined all these measures in a multi-level model that shows how tight and loose systems are developed and maintained.

Gelfand said knowledge about these cultural differences can be invaluable to many people--from diplomats and global managers to military personal, immigrants and travelers--who have to traverse the tight-loose divide.

"When we understand why cultures, and the individuals in those cultures, are the way they are, it helps us to become less judgmental. It helps us to understand and appreciate societal differences."

-NSF-

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http://www.nsf.gov/news/news_summ.jsp?cntn_id=119679

Ecologists find genomic clues to invasive and endangered plants

Findings could be used in conservation and control efforts.
Natasha Gilbert

Genomic data could help control invasive plants, like this kudzu in the south-eastern United States.u99/ZUMA Press/Newscom

Ecologists have discovered strong links between how many sets of chromosomes a plant species has and whether it is in danger of becoming rare, or conversely, becoming invasive. The findings[1] could help conservation scientists to predict whether species will need protecting or controlling and how to allocate resources to these efforts.

Until now, ecologists have had varied success in finding reliable indicators to help them predict whether species are likely to become endangered or invasive.

Most attempts have focused on taxonomic or ecological traits such as the size of the geographical area that the species is found in, while a handful of small-scale studies have looked at genomic traits. But all have proven "equivocal", says Maharaj Pandit, a plant ecologist at the University of Delhi in India, and lead author of the study.

"Our findings show clear trends and demonstrate the importance of genomic attributes as risk factors of vulnerability to endangerment or invasiveness in plants," he says.

All in the genes

The researchers collected chromosome data on 640 endangered species across from the globe and from more than 9,000 related species. They collected the same data for 81 invasive species and around 2,300 of their relatives. In doing so, the researchers have built the biggest data set of its kind. The study was published online last week in the Journal of Ecology.

The researchers found that endangered plants, such as Viburnum bracteatum, are "disproportionately" likely to have only two sets of chromosomes (diploid). Invasive plants, however, such as the noxious weed Parthenium hysterophorus generally had multiple sets of chromosomes (polyploid) and higher overall numbers of chromosomes.

They found that invasive plants are 20% more likely to be polyploids than diploids, and a species is 12% more likely to become invasive if given the chance as its chromosome number doubles. By contrast, endangered plant species are 14% less likely to be polyploids than diploids, the study finds.

The "very strong signals indicating rarity and invasiveness" could be incorporated into existing efforts to assess the risks of invasive and endangered species, adds Michael Pocock, an ecologist at the University of Bristol, UK, and another of the study's authors.

Adaptability

The researchers say that having multiple sets of chromosomes is often associated with a plant's vigour and the ability to adapt to different environments. This could enable plants to be more competitive and potentially invasive in a new environment. But further research is needed to pin down whether ploidy causes invasiveness or rarity, they say.

"There is a need to improve our ability to predict the potential invasiveness of alien species," says Piero Genovesi, a conservation ecologist and chairman of the invasive species unit of the International Union for Nature Conservation. This study "adds an important brick to the construction" of those efforts, he explains.

Genovesi says that he does not know of any risk-assessment methods that consider ploidy to help judge whether a plant species could become invasive. But he adds that the findings will not provide an "ultimate tool" to address invasions.
"It is very unlikely we will ever be able to predict invasiveness with full certainty," Genovesi says.

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US radiation study sparks debate

Researchers divided on how best to probe any possible link to cancer.

Gwyneth Dickey Zakaib

Some studies have found links between childhood cancer and proximity to power stations.VENTURE MEDIA GROUP/AURORA PHOTOS/CORBIS

Japan's ongoing nuclear emergency has intensified discussion on a simmering issue: the potential cancer risk from living near a reactor that is operating normally.

Last year, long before the crisis in Japan, the US Nuclear Regulatory Commission (NRC) asked the National Academy of Sciences (NAS) to examine this cancer question, prompted in part by long-standing public unease. The NAS is now consulting with experts about how to design a study, with the next public meetings on the effort scheduled for 18–19 April in Chicago, Illinois. Already, however, some researchers have questioned the study's feasibility and expressed doubt over whether it will produce meaningful results.

According to the NRC, less than 1% of a person's total annual background-radiation exposure comes from living near nuclear power plants. Much more comes from natural sources in the earth and air, and from some medical exams. Even so, "there are recurrent concerns among the public about increased cancer risks", says Terry Brock, the NRC's project manager for the Analysis of Cancer Risk in Populations Near Nuclear Facilities study. "We want the most current and most scientifically valid information to respond."

The last US-wide study, which found no evidence of a problem, was published by the National Cancer Institute in 1990. Now the NRC aims to update this effort by taking advantage of two decades of improvements in data and technology. For example, whereas the 1990 study considered only cancer deaths, better record-keeping means that researchers can now look for suspect patterns in cancer diagnoses. The previous study also lumped people by county, regardless of their actual distance from a nuclear plant. Global positioning systems, which can pinpoint where people live in relation to a reactor, should now help provide more meaningful results. A further step would be including estimates of radiation doses and looking for correlations with cancer incidence.

But Edward Maher, president of the US-based Health Physics Society, says that even if the study takes all of those factors into account, its statistical power will be too low.

“They may make the public feel better, but they're not going to see very low-dose effects.”

"We feel that those studies don't have a lot of value," says Maher. "They may make the public feel better, but they're not going to see very low-dose effects." The money would be better spent on more laboratory research, he adds, where confounding factors such as the presence of other carcinogens can be effectively controlled.

Other experts say that the NAS should build on and improve a 2008 German study (C. Spix et al. Eur. J. Cancer **44,** 275–284; 2008), which found a roughly 1.5-fold increase in cancers in children younger than 5 living within 5 kilometres of nuclear power plants. The authors concluded that plant emissions were too low to explain the effect, and similar studies done later in France and Britain failed to show any cancer increase, but some researchers have challenged their interpretation of the data.

Nevertheless, Steve Wing, an epidemiologist from the University of North Carolina at Chapel Hill, says that if there is an effect, it will be easiest to see in children and fetuses. Their rapidly dividing cells make them more sensitive to radiation than adults, and they haven't been exposed to as many possible carcinogens. Wing and his colleagues wrote an article on how best to design the NAS study in the 1 April issue of Environmental

Health Perspectives (S. Wing et al. Environ. Health Perspect. doi:10.1289/ehp.1002853; 2011). Among other things, they emphasize the need to obtain radiation-dose estimates for the populations under study.
In the upcoming April meetings, the NAS committee will discuss nuclear power plant emission monitoring and hear study design suggestions. After a series of additional meetings, the committee aims to complete recommendations by the end of 2011, after which they will be posted online for public comment. If the committee decides to move forward with the study, another committee will be appointed next year to carry it out.
Some experts think that there is no effect for the study to find. Antone Brooks, a radiation toxicologist at Washington State University Tri-cities in Richland, says that DNA repair mechanisms and selective suicide of damaged cells are adequate to handle DNA damage below a certain dose threshold.
"We've lived in a sea of radiation throughout evolution," says Brooks. "The body knows how to handle low doses."

Others believe that the risk never vanishes. DNA repair mechanisms don't work perfectly 100% of the time, and even small amounts of radiation confer some risk, says Bill Morgan, the director of radiation biology and biophysics at Pacific Northwest National Laboratory in Richland. "It's a tremendous debate," he says.
Some will argue that if no effect is found, there isn't a problem, says David Brenner, director of the Center for Radiological Research at Columbia University in New York. "But the fact that you can't measure a risk in an epidemiological study doesn't mean that the risk isn't there."

http://www.nature.com/news/2011/110406/full/472015a.html

Materials science: The pull of stronger magnets

Super-powerful magnets would boost the performance of electric cars and other green technology. Why is it so hard to make them?
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Despite their name, rare-earth elements such as neodymium aren't truly rare geologically, but they are expensive to mine and process. China, which provides about 95% of the 96,000 tonnes currently produced worldwide every year, has put increasingly stringent caps on exports, even as the need for the elements is booming. Magnets made with them are at the heart of modern technology from mobile phones and laptops to high-efficiency washing machines. And many devices that are part of the green economy require substantial amounts: an electric car carries a few kilograms of rare-earth elements, and a 3-megawatt wind turbine uses about 1.5 tonnes. Demand leapt from 30,000 tonnes in the 1980s to 120,000 tonnes in 2010 (which was met in part by depletion of national stockpiles), and is predicted to hit 200,000 tonnes by 2015, says Gareth Hatch, founder of the Technology Metals Research consultancy in Carpentersville, Illinois (see 'Market forces').

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energy-efficient technology, and scared by a global crunch in the rare-earth market, have started to pay attention to magnetics research.

In the United States, an infusion of funds has come from the Department of Energy, home of the Advanced Research Projects Agency — Energy (ARPA-E), which was established in 2009 to bring high-risk, potentially 'transformative' technologies to the market. ARPA-E has allocated $6.6 million to research on next-generation magnets — a shot in the arm for the field. "We're long overdue" for the next magnet revolution, says George Hadjipanayis, a physicist at the University of Delaware in Newark, who is head of a $4.4-million ARPA-E consortium of which McCallum is part. "We need to do it."

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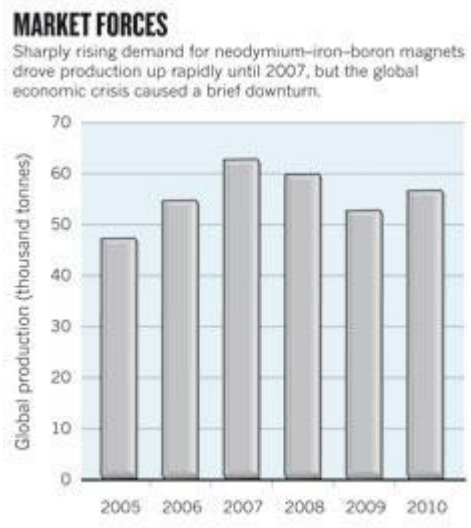

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Although the United States seems to be making the most concerted push towards creating the strongest magnets, other nations have invested more money in general magnetics research, says Liu. China's 5-year economic plan for 2011–15 includes a big boost — reportedly more than 4 trillion renminbi (US$610 billion) — for spending in seven 'strategic emerging industries', including energy systems, clean cars and new materials. Observers such as Hatch and Liu expect great things from the investment. Japan has invested heavily in magnet research for its high-tech industry, and has strong government–industry collaborations — although one of its largest centres for magnetics research is Tohoku University in Sendai, which was hit hard by the earthquake and tsunami in March (see Nature **471,** 420; 2011).
Last year, the European Union's research-funding framework put out a €4-million (US$6.3-million) call for proposals from groups working to develop novel materials, with the goal of totally replacing rare earths. But most researchers say that this is massively overreaching. "This is a joke, scientifically," says Liu of the quest to remove rare earths from strong magnets. Several major labs have had proposals rejected because they aimed simply to reduce the quantities of rare earths used in magnets, says Dominique Givord, a magnetics researcher at the Louis Néel Laboratory in Grenoble, France.

Researchers' target of building next-generation nanocomposite magnets is, most admit, a long shot. "I know that this activity is becoming popular in the United States, but I feel that their goal is a bit too ambitious," says Kazuhiro Hono, a magnetics researcher at the National Institute for Materials Science in Tsukuba, Japan. Givord agrees. "It is extraordinarily challenging," he says. More realistic, he says, are attempts to make existing magnets a bit stronger and cheaper by altering their microstructures. In Japan, such efforts have helped to reduce dysprosium demand.
But Hatch, who has worked in the field for nearly two decades, says that next-generation magnets are worth the battle. "Yes, it is ambitious, but that's exactly why we need to be doing it," he says. "It's time to put money behind it."
Nicola Jones is a freelance journalist based near Vancouver, Canada.

http://www.nature.com/news/2011/110406/full/472022a.html

Fattening up Schrödinger's cat

Huge molecules can show the wave-particle duality of quantum theory.
Philip Ball

I can haz superposition?VICTOR DE SCHWANBERG / SCIENCE PHOTO LIBRARY

Researchers in Austria have made what they call the "fattest Schrödinger cats realized to date". They have demonstrated quantum superposition – in which an object exists in two or more states simultaneously – for molecules composed of up to 430 atoms each, several times larger than molecules used in previous such experiments[1].

In the famous thought experiment conceived by Erwin Schrödinger in 1935 to illustrate the apparent paradoxes of quantum theory, a cat would be poisoned or not depending on the state of an atom — the atom's state being governed by quantum rules. Because quantum theory required that these rules allowed superpositions, it seemed that Schrödinger's cat could itself exist in a superposition of 'live' and 'dead' states.

The paradox highlights the question of how and when the rules of the quantum world – in which objects such as atoms can exist in several positions at once – give way to the 'classical' mechanics that governs the macroscopic world of our everyday experience, where things must be one way or the other but not both at the same time. This is called the quantum-to-classical transition.

It is now generally thought that 'quantumness' is lost in a process called decoherence, in which disturbances in the immediate environment make the quantum wavefunction describing many-state superpositions appear to collapse into a well-defined, unique classical state. This decoherence tends to become more pronounced the bigger the object, as the opportunities for interacting with the environment increase.

One manifestation of quantum superposition is the interference that can occur between quantum particles passing through two or more narrow slits. In the classical world the particles pass through with their trajectories unchanged, like footballs rolling through a doorway.

But quantum particles can behave like waves, which interfere with one another as they pass through the slits, either enhancing or cancelling each other out to produce a series of bright and dark bands. This interference of quantum particles, first seen for electrons in 1927, is effectively the result of each particle passing through more than one slit: a quantum superposition.

As the experiment is scaled up in size, at some point quantum behaviour (interference) should give way to classical behaviour (no interference). But how big can the particles be before that happens?

Scaling up

In 1999, a team at the University of Vienna demonstrated interference in a many-slit experiment using beams of 60-atom carbon molecules (C_{60}), which are shaped like hollow spheres[2]. Now Markus Arndt, one of the researchers involved in that experiment, and his colleagues in Austria, Germany, the United States and Switzerland have shown much the same effect for considerably larger molecules tailor-made for the purpose — up to 6 nanometres (millionths of a millimetre) across and composed of up to 430 atoms. These are bigger than some small protein molecules, such as insulin.

In the team's experiment, the beams of molecules are passed through three sets of slits. The first slit, made from a slice of silicon nitride patterned with a grating consisting of slits 90 nanometres wide, forces the molecular beam into a coherent state, in which the matter waves are all in step. The second, a 'virtual grating' made from laser light formed by mirrors into a standing wave of light and dark, causes the interference

pattern. The third grating, also of silicon nitride, acts as a mask to admit parts of the interference pattern to a quadrupole mass spectrometer, which counts the number of molecules that pass through.
The researchers report in Nature Communications today that this number rises and falls periodically as the outgoing beam is scanned from left to right, showing that interference, and therefore superposition, is present. Although this might not sound like a Schrödinger cat experiment, it probes the same quantum effects. It is essentially like firing the cats themselves at the interference grating, rather than making a single cat's fate contingent on an atomic-scale event.

Quantum physicist Martin Plenio of the University of Ulm in Germany calls the study part of an important line of research. "We have perhaps not gained deep new insights into the nature of quantum superposition from this specific experiment," he admits, "but there is hope that with increasing refinement of the experimental technique we will eventually discover something new."
Arndt says that such experiments might eventually allow tests of fundamental aspects of quantum theory, such as how wavefunctions collapse under observation. "Predictions, such as that gravity might induce wavefunction collapse beyond a certain mass limit, should become testable at significantly higher masses in far-future experiments," he says.
Can living organisms – perhaps not cats, but microorganisms such as bacteria – be placed in superpositions? That has been proposed for viruses[3], the smallest of which are just a few nanometres across – although there is no consensus about whether viruses should be considered truly alive. "Tailored molecules are much easier than viruses to handle in such experiments," says Arndt. But he adds that if various technical issues can be addressed, "I don't see why it should not work".

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Antarctic microbes live life to the extreme

Chilean Antarctic survey finds dramatic variety of organisms adapted to unusual conditions.
Patricio Segura Ortiz

Chilean scientists sought organisms with traits that could be developed into useful biotechnologies.Jenny Blamey

You might not expect bacteria living in Antarctic ice to be well suited to life in a boiling kettle, but that is what Chilean scientists discovered during an expedition last year. The researchers have turned up more than 200 new species of microorganisms adapted to living in extreme environments.

"We have discovered over 300 microorganisms, of which 70% correspond to new species," says Jenny Blamey, a biochemist and director of the Biosciences Foundation in Santiago, a leading organisation in Antarctic Bioresources, a public–private initiative begun in 2008 to identify biological resources with potential biotechnological uses in this largely unexplored territory. She and her colleagues were part of Antarctic Scientific Expedition 47 (ECA-47), which was organized by the Chilean Antarctic Institute in Puntas Arenas and involved multiple research projects over the southern summer of 2010–11. The team presented some of their results at a press conference in Punta Arenas, Chile, last month.

Blamey's team focused on searching for extremophiles in the South Shetland Islands. They were not disappointed.

As might be expected, the group discovered many psychrophiles — organisms that thrive in conditions cooler than 15 ºC — as well as halophiles, which survive in high concentrations of salt, and acidophiles and alkaliphiles, which can tolerate extremes of pH.

But the researchers also found a surprising number of thermophiles and hyperthermophiles, which prefer temperatures above 50 ºC, including one microbe that could survive at 95 ºC despite spending its life encased in the ice. Such an organism, they say, must have evolved when the Antarctic environment was very different to how it is today.

Another strange discovery is a previously unknown Deinococcus — a group of bacteria known as the world's toughest — capable of tolerating γ-ray exposures 5,000 times greater than those survived by any other known organism, despite living 15 metres beneath the permafrost. These levels of radiation have never existed on Earth, so the source of the bacterium's resistance is a mystery. Theories put forth so far include that the microbe had an extraterrestrial origin. Blamey says that at this point, no theory has been discarded.

"We seek to understand the molecular mechanisms that grant such levels of resistance. We wish to determine which mechanisms this microorganism possesses in order to protect itself from the effects of radiation, as well as conceive their potential applications," she says.

Technology tips

The team has also identified psychrophiles resistant to ultraviolet radiation, which use enzymes to capture reactive oxygen species. These organisms might have practical biotechnology applications: researchers predict that they could eventually find a use in technologies designed to protect people against solar and UV radiation.

A potentially useful organism isolated in shallow marine sediment samples had the ability to grow in highly salty environments and at temperatures as low as 4 ºC. In lab tests, Freddy Boehmwald, a biologist at the Bioscience Foundation, investigated the molecular strategies that help these microorganisms to live under extreme conditions. He says that some of the molecules that accumulate in the microbes are known biostabilizers, and he suggests that they could have applications in the cosmetics and pharmaceutical industries.

Paris Lavin, a microbiologist at the Chilean Antarctic Institute, studied 270 strains of actinomycete bacteria — the order that produces streptomycin antibiotics — isolated from seven lagoons on Antarctica's King George Island, one of the South Shetland Islands. Because the organisms have been so remote, other bacteria are unlikely to have developed resistance to the antibiotic toxins that they produce, making them good candidates for new drugs.

Lavin says that the extreme temperatures and exposure to ultraviolet radiation in Antarctica allow the area to "function as a natural laboratory that promotes the selection of organisms resistant to such pressures". And the solutions that evolution has come up with could find a use elsewhere in the world.

http://www.nature.com/news/2011/110404/full/news.2011.207.html

Rare-disease project has global ambitions

Consortium aims for hundreds of new therapies by 2020.
Alison Abbott
Prader–Willi syndrome. Fabry renal disease. Spinocerebellar ataxia. Few people have heard of these and the other 'rare diseases', some of which affect only hundreds of patients worldwide. Drug companies searching for the next blockbuster pay them little attention. But the diseases are usually incurable — and there are thousands of them.
This week, the US National Institutes of Health (NIH) and the European Commission launch a joint assault on these conditions, whose small numbers of patients make it difficult to test new treatments and develop diagnostic methods. The International Rare Disease Research Consortium being formed under the auspices of the two bodies has the ambitious goal of developing a diagnostic tool for every known rare disease by 2020, along with new therapies to treat 200 of them. "The number of individuals with a particular rare disease is so small that we need to be able to pool information from patients in as many countries as possible," says Ruxandra Draghia-Akli, the commission's director of health research.
"We need to be able to pool information from patients in as many countries as possible."

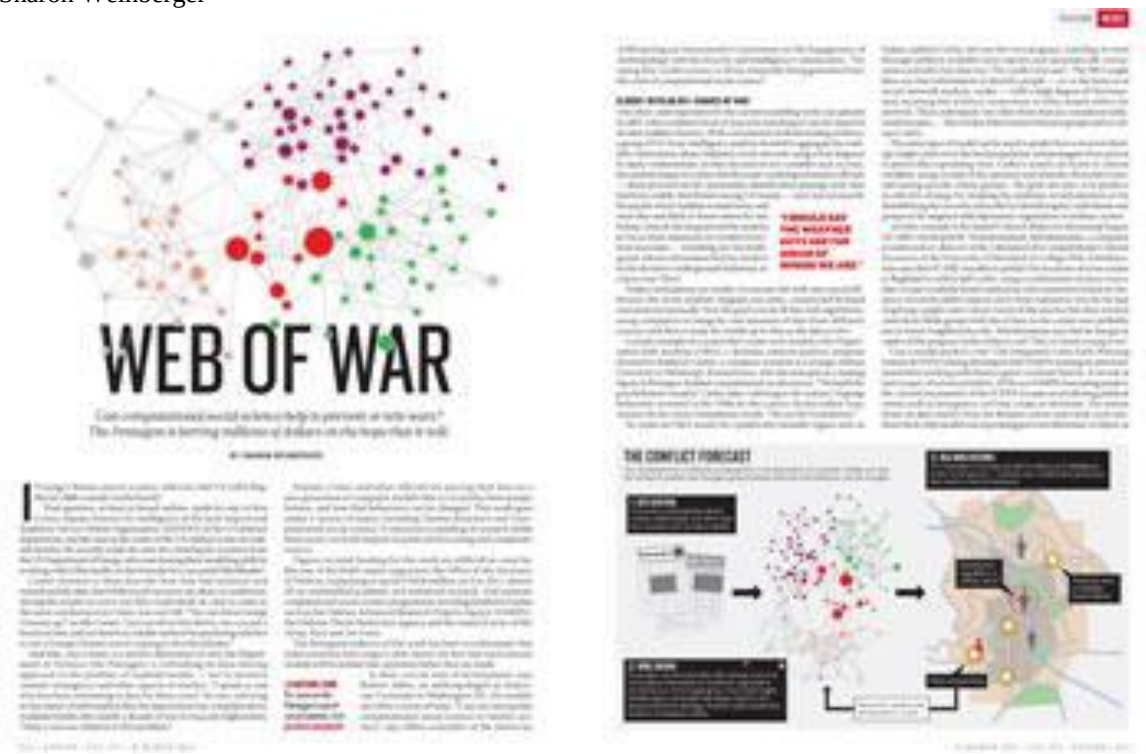
At the launch meeting in Bethesda, Maryland, on 6–8 April, prospective partners will map out research strategies to identify diagnostic biomarkers, design clinical trials and coordinate genome sequencing in these diseases. Nearly all the rare diseases, of which there are an estimated 6,000–8,000, are the result of small genetic changes.
The meeting will also discuss the governance of the project, which is most likely to be modelled on the pioneering Human Genome Project. As such, the consortium is open to research agencies and organizations from all over the world. Representatives from countries including Canada, Japan and some individual European nations are all attending the meeting, and may join the consortium. Those wishing to participate will have to pledge a minimum financial contribution, which has not yet been agreed, and share all relevant data. Indeed, the project will have to overcome numerous obstacles to information sharing, such as the fact that physicians in different countries often use entirely different words to describe the same disease.
Draghia-Akli points out that the project could yield major benefits for the emerging field of personalized medicine — another political priority for the NIH and the commission — which also faces the challenge of small populations of patients.
Regulatory agencies such as the US Food and Drug Administration and the European Medicines Agency rely on large, randomized and controlled clinical trials when deciding whether to approve new medicines, and one of the aims of the consortium will be to develop alternative clinical-trial methods for diseases that affect few people.

These methods are becoming ever more important now that genome analysis is helping to break down common diseases into ever smaller subclasses. "Soon there will be no disease called breast cancer," says Draghia-Akli. Instead, the catch-all term will be replaced by "a large number of rare diseases, each of which causes malignant growth in breast tissue and requires individual treatment", she says.
The commission will launch a €100-million (US$140-million) call for research proposals in July, which will support the consortium's scientific goals by focusing heavily on developing appropriate clinical trials.

http://www.nature.com/news/2011/110404/full/472017a.html

Social science: Web of war

Can computational social science help to prevent or win wars? The Pentagon is betting millions of dollars on the hope that it will.
Sharon Weinberger

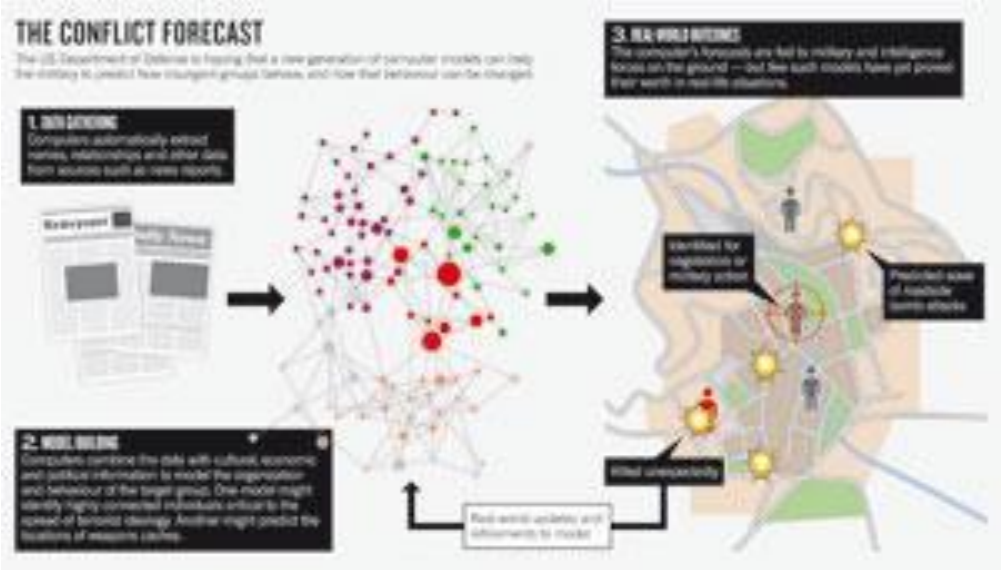


If George Clooney stars in a movie, will it be a hit? Or will it flop, like his 2008 comedy Leatherheads? That question, at least in broad outline, made its way to Ken Comer, deputy director for intelligence at the Joint Improvised Explosive Device Defeat Organization (JIEDDO) of the US defence department, and the man at the centre of the US military's war on roadside bombs. He recently made the time for a briefing by scientists from the US Department of Energy, who were honing their modelling skills by working with a film studio on the formula for a successful blockbuster.
Comer listened to them describe how they had analysed and reanalysed the data that Hollywood vacuums up about its audiences, slicing the results in every way they could think of, only to come to the same conclusion every time: you can't tell. "You can dress George Clooney up," recalls Comer, "you can dress him down, you can put a beard on him, and yet there's no reliable method for predicting whether or not a George Clooney movie is going to be a blockbuster."
And that, says Comer, is a perfect illustration of why the Department of Defense (the Pentagon) is rethinking its data-mining approach to the problem of roadside bombs — not to mention counter-insurgency and other aspects of warfare. "I speak as one who has been swimming in data for three years," he says, referring to the reams of information that the department has compiled about roadside bombs after nearly a decade of war in Iraq and Afghanistan: "Data is not our solution to this problem."
Instead, Comer and other officials are placing their bets on a new generation of computer models that try to predict how groups behave, and how that behaviour can be changed. This work goes under a variety of names, including 'human dynamics' and 'computational social science'. It represents a melding of research fields from social-network analysis to political forecasting and complexity science.
Figures on total funding for this work are difficult to come by. But one of the field's major supporters, the Office of the Secretary of Defense, is planning to spend US$28 million on it in 2011, almost all on unclassified academic and industrial research. And separate computational social-science programmes are

being funded by bodies such as the Defense Advanced Research Projects Agency (DARPA), the Defense Threat Reduction Agency and the research arms of the Army, Navy and Air Force.
The Pentagon's embrace of this work has been so enthusiastic that some scientists have urged a slow-down, for fear that such nascent models will be pushed into operation before they are ready.
In their current state of development, says Robert Albro, an anthropologist at American University in Washington DC, the models are often a waste of time. "I am not saying that computational social science is voodoo science," says Albro, a member of the American Anthropological Association's Commission on the Engagement of Anthropology with the Security and Intelligence Communities. "I'm saying that voodoo science is all too frequently being generated from the work of computational social science."

Cloudy, with an 80% chance of war

One often-cited inspiration for the current modelling work is an episode in 2003, when coalition forces in Iraq were searching in vain for deposed dictator Saddam Hussein. With conventional methods leading nowhere, a group of US Army intelligence analysts decided to aggregate the available information about Saddam's social network using a link diagram to depict relationships. As they factored in key variables such as trust, the analysts began to realize that the most-wanted government officials — those pictured on the 'personality identification playing cards' that had been widely distributed among US troops — were not necessarily the people whom Saddam trusted most, and were thus not likely to know where he was hiding. Instead, the diagram led the analysts to focus their attention on trusted lower-level associates — including one key bodyguard, whose information led the trackers to the dictator's underground hideaway on a farm near Tikrit.
Today's simulations are similar in concept, but with one crucial difference: the Army analysts' diagram was static, constructed by hand and analysed manually. Now the goal is to do all that with algorithms, using computers to integrate vast amounts of data from different sources, and then to keep the results up to date as the data evolve.
A prime example of a system that creates such models is the Organization Risk Analyzer (ORA): a 'dynamic network analysis' program devised by Kathleen Carley, a computer scientist at Carnegie Mellon University in Pittsburgh, Pennsylvania, who has emerged as a leading figure in Pentagon-funded computational social science. "We build the psychohistory models," Carley jokes, referring to the 'science' of group behaviour invented in the 1940s by the science-fiction author Isaac Asimov for his classic Foundation novels. "We are the Foundation!"



To create an ORA model for a politically unstable region such as Sudan, explains Carley, she uses her own program, AutoMap, to trawl through publicly available news reports and automatically extract names and other key data (see 'The conflict forecast'). The ORA might then use that information to identify people — or, in the lexicon of social-network analysis, nodes — with a high degree of 'betweenness', meaning lots of direct

connections to other people within the network. These individuals "are often those that are considered influential because … they broker information between groups and so on", says Carley.
The same types of model can be used to predict how a terrorist ideology might catch on in the local population and propagate from person to person like a spreading virus. Carley's system can factor in cultural variables, using records of the opinions and attitudes that tend to prevail among specific ethnic groups. The goal, she says, is to produce an effective strategy for stopping the epidemic of radicalization or for destabilizing the terrorist networks by identifying key individuals and groups to be targeted with diplomatic negotiation or military action.
Another example is the Spatial Cultural Abductive Reasoning Engine (SCARE) developed by Venkatramanan Subrahmanian, a computer scientist and co-director of the Laboratory for Computational Cultural Dynamics at the University of Maryland in College Park. Subrahmanian says that SCARE was able to predict the locations of arms caches in Baghdad to within half a mile, using a combination of open-source data on past roadside bomb explosions and constraints based on distance (terrorists didn't want to carry their explosives very far for fear of getting caught) and culture (most of the attacks that they tracked came from Shiite groups with ties to Iran, so the caches were probably not in Sunni neighbourhoods). Subrahmanian says that he has given copies of the program to the military, and "they're clearly trying it out".
“I would say the weather guys are far ahead of where we are.”

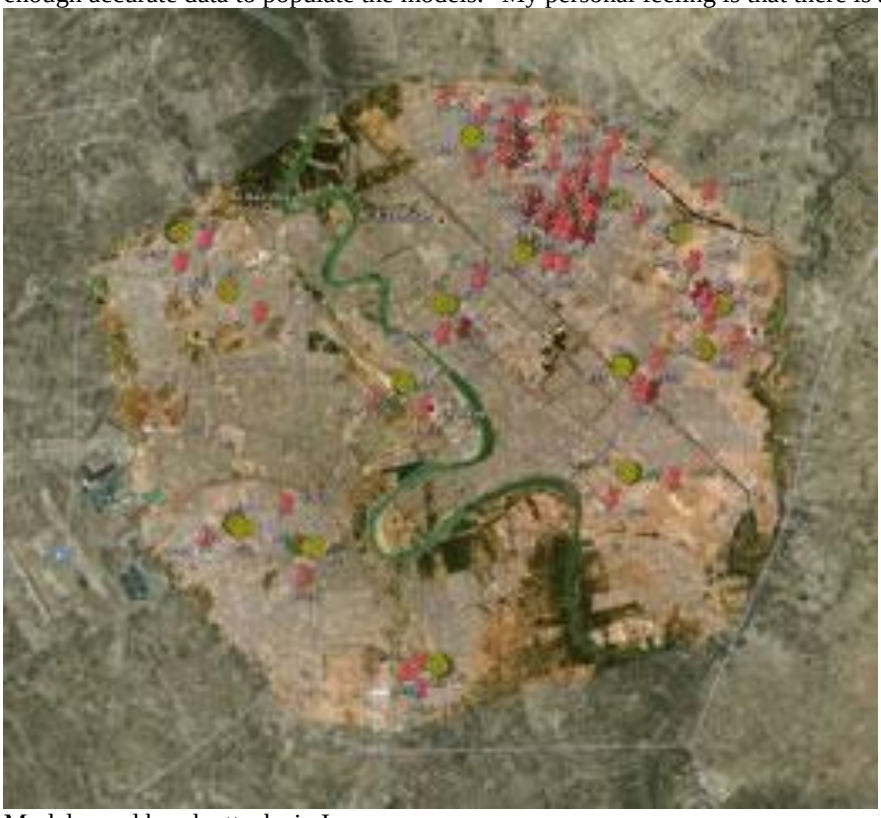
Can a model predict a war? The Integrated Crisis Early Warning System (ICEWS) is being developed with DARPA funding by university researchers working with defence giant Lockheed Martin. A revival, at least in part, of a more primitive, 1970s-era DARPA forecasting project, the current incarnation of the ICEWS focuses on predicting political events such as insurgency, civil war, coups or invasions. The system draws its data mainly from the Reuters online news feed, and combines them with models incorporating previous behaviour of ethnic or political groups, economic factors such as a country's gross domestic product and geopolitical relationships with neighbouring countries. The result is an ICEWS forecast that might predict, for example, that 'Country X has a 60% probability of civil war'.
The ICEWS has been producing monthly predictions since March 2010, says Sean O'Brien, programme manager for the effort at DARPA. He believes that such models, although imperfect, are already nearing the point at which they can be useful for military leaders. O'Brien has considerable company elsewhere in the Pentagon: the Office of Director of Defense Research and Engineering, for example, is sponsoring its own programme in Human, Social, Cultural and Behavior modelling. And although the office did not provide details, it says that some of its simulations are already being used by the US Special Operations Command and the US Africa Command.

A generation away

Even among researchers working on models with Pentagon funding, there is concern that such enthusiasm may be premature. It seems, for example, that neither computer models nor human analysts were able to precisely predict this year's uprisings in the Middle East.
When it comes to prediction, "I would say the weather guys are far ahead of where we are", says Subrahmanian, who notes that meteorologists are frequently accused of being wrong as much as they are right. "And that might give you some relative understanding of where the science is."
Carley points to the pitfalls of automated data collection. "One of the issues," she says, "is that you will get people who are … talked about as part of the networks who aren't technically alive." In the ORA model for Sudan, for example, the textual analysis resulted in a network in which one of the key individuals was Muhammad — the Islamic prophet who died in AD 632.

Albro, who has reviewed a number of computational social-science models as part of the US National Research Council's Committee on Unifying Social Frameworks, worries that much of the work is being done by computer scientists, with only token input from social scientists, and that minimal attention is being paid to where the data come from, and what they mean. He points to some models that look for signs of extremist violence by tracking phrases such as "blow up" in online social-media discussions. "There's the constant implication that discursive violence adds up to real violence, and that's crazy," he says.
Robert Axtell, a computational social scientist at the Krasnow Institute for Advanced Study at George Mason University in Fairfax, Virginia, and a pioneer of agent-based modelling, argues that there simply aren't

enough accurate data to populate the models. "My personal feeling is that there is a large research programme



Models used bomb attacks in Iraq

to be done over the next 20 years, or even 100 years, for building good high-fidelity models of human behaviour and interactions," he says.
Similar notes of caution can be heard within the defence department. "We're at the very beginnings of this," says John Lavery, who manages a programme of complex-systems modelling at the Army Research Office in Research Triangle Park, North Carolina, and who compares the current state of computational social science with physics in the early nineteenth century.
“As soon as they delivered it we said, 'Gee, thanks. Now you'll have to rewrite it that for Afghanistan.'”

"It's a tool, and if you can leverage it, that's great," agrees Brian Reed, a behavioural scientist at the Network Science Center of the US Military Academy at West Point, New York, who was a key architect of the network analysis that led to Saddam's capture. "But you can get too much information," he warns, "and someone has to provide a focus." Reed cites an example from his own return to Iraq, where he was deployed from 2008 to 2009 in the province of Diyala. Wanting to stop roadside bomb attacks, he asked his intelligence organization for a network analysis of the insurgent network. They provided an overload of data. "What they crunched, no one at our end could understand," says Reed.
Critics such as Albro worry that too many researchers are unaware of the real limitations of their work. Many of the models that Albro has seen focus on verification — ensuring that the simulations are internally consistent — but give short shrift to validation, or making sure that they correlate to something in the real world. The models might provide an interpretative tool that allows policy-makers or military leaders to think critically about a problem, he suggests, but the technique's limitations are sometimes overlooked. "It does not answer our questions for us," says Albro. "It does not solve that dilemma of what decision I need to make."
Indeed, it is often far from clear whether the current generation of models is telling people anything that an expert in the relevant subject wouldn't already know. Carley recalls a conference at which she presented her

results about the key individuals whom her ORA model had identified in Sudan. "Yeah," came the response from the regional specialists in the audience, "we kind of knew most of this."
For all the caveats, however, the need to help soldiers on the ground carries an acute sense of urgency back at JIEDDO headquarters. "We have a few instances of models that have docked with the data successfully," says Comer, citing an agent-based simulation of the Iraqi city of Samarra, which was funded by JIEDDO. "The big magic trick is to move those models to a point where they can be predictive."
The model of Samarra was able to match specific changes in US military strategy to decreases or increases in the incidence of roadside bombs, but it was specific to that city. The researchers "did a great model and it was really useful", says Comer. "Just as soon as they delivered it we said, 'Gee, thanks. Now you'll have to rewrite that for Afghanistan.'"

Comer acknowledges the irony that as the world's most technologically advanced military spends tens of millions of dollars on sophisticated computer tools to predict insurgent behaviour, the insurgents in question are busy building crude bombs with little more than fertilizer and basic electronics.
"The enemy is holding his own," says Comer, "not only without the data, but without the computer power, without the Internet, without the databases — and without the science."
Sharon Weinberger is an Alicia Patterson Foundation Fellow based in Washington DC.

http://www.nature.com/news/2011/110404/full/471566a.html

Carbon-rich mangroves ripe for conservation

Failing to preserve mangrove forests could cause sizeable carbon emissions.

Janelle Weaver

Until now, the amount of carbon locked up in mangrove forests was largely unknown.Dan Donato

Mangrove forests in tropical regions of the Indian and Pacific Oceans store more carbon than previously recognized, according to a study published today in Nature Geoscience[1]. The findings indicate that much of the carbon in such forests is found in the surrounding soil, which is rich in organic material. Cutting down mangrove forests, which occupy less than 1% of tropical forest area, could therefore contribute up to 10% of global carbon emissions from deforestation.

Although carbon reserves in other types of tropical wetland forest have been assessed, the amount of carbon in mangroves has been largely ignored, even though they are present in more than 100 countries. For example, it is estimated that clearing of tropical peatlands, which also contain carbon-rich soils, produces about a quarter of all deforestation emissions. The extent of mangrove forests has declined by as much as 50% over the past half century because of development, over-harvesting and aquaculture, so estimating their carbon reserves will be important for future strategies to reduce climate change.

To estimate the abundance of carbon in mangroves, lead investigator J. Boone Kauffman, an ecologist at the Northern Research Station of the US Forest Service in Durham, New Hampshire, and his team sampled 25 mangrove sites across a broad territory that included Micronesia, Indonesia and Bangladesh. This area spans 30 degrees of latitude and 73 degrees of longitude and represents about 40% of the global area covered by these trees.

Sludge stores

Kauffman and his team assessed above-ground and below-ground carbon pools in mangrove sites occupying estuaries and oceanic settings, such as island coasts. They found that these forests hold much more carbon than do boreal, temperate or tropical upland forests — especially in an organic-rich 'muck layer' of soil more than 30 centimetres below the surface.

The team found that this underground layer is thicker in mangrove forests in estuaries than in those near the ocean, accounting for more than 70% of total carbon stores in estuarine mangroves and upwards of 50% in those in oceanic zones.

By combining their findings with global data, the researchers predict that worldwide carbon reserves in mangrove forests may be as high as 25% of those in tropical peatlands, and at the current rate of annual clearance, emissions from mangrove destruction could reach 40% of those from the clearing of peatlands.

Branching out

"This paper represents an important step forward in quantifying and understanding the significant pool of carbon in mangrove ecosystems," says Shimon Anisfeld, an expert in coastal ecology at Yale University in New Haven, Connecticut.

However, the numbers still only represent rough estimates, owing to a lack of information about geographic variation in soil depth, the relative area of mangrove forests in estuaries compared with those near oceans, and the effect of land-use changes on carbon release from soils. They may even be overestimates, because "the authors seem to have sampled some of the largest, most robust stands around," says Thomas Smith, an ecologist at the US Geological Survey in St Petersburg, Florida.

Still, the study could have a substantial impact on conservation efforts around the world, says Gail Chmura, an expert in coastal ecosystems at McGill University in Montreal, Canada. "Hopefully, it will help arguments to extend REDD+ to mangroves," she says, referring to an international plan to pay developing countries to preserve forests in a bid to help reduce global carbon emissions.

Robert Jackson, an ecologist at Duke University in Durham, North Carolina, agrees with Chmura, adding: "Mangrove forests are important for diversity, for coastal stability and for carbon, based on this paper. It gives another justification for preserving mangrove forests."

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http://www.nature.com/news/2011/110403/full/news.2011.205.html