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Classical Music Linked to High Intelligence

An evolutionary theorist provides evidence that intelligent individuals are more likely to enjoy purely instrumental music.

By Tom Jacobs

Do smart people populate concert halls and jazz clubs because they're more likely to respond to purely instrumental works? (wragg/istockphoto)

Is a preference for classical music a sign of superior intelligence? Newly published research suggests the answer is yes, but — cue an ominous minor chord — not for the reason you might think.

Like Mozart or Mahler, researcher Satoshi Kanazawa of the London School of Economics and Political Science takes a few imaginative leaps to arrive at his conclusion. His latest paper, just published in the *Journal of Behavioral Decision Making,* may prove as controversial as his last one, which suggested highly intelligent people are more likely to be atheists and political liberals.

Using theories of evolutionary psychology, he argues smart people populate concert halls and jazz clubs because they're more likely to respond to purely instrumental works. In contrast, pretty much everyone enjoys vocal music.

His reasoning is based on what he calls the Savanna-IQ Interaction Hypothesis, which suggests intelligent people are more apt than their less-brainy peers to adopt evolutionary novel preferences and values. Pretty much everyone is driven to some degree by the basic behavior patterns that developed early in our evolutionary history. But more intelligent people are better able to comprehend, and thus more likely to enjoy, novel stimuli.

Novel, in this context, is a relative term. From an evolutionary viewpoint, novel behavior includes everything from being a night owl (since our prehistoric ancestors, lacking light sources, tended to operate exclusively in the daylight) to using recreational drugs.

Songs predated sonatas by many millennia. So in evolutionary terms, purely instrumental music is a novelty — which, by Kanazawa's reckoning, means intelligent people are more likely to appreciate and enjoy it.

Such a thesis is virtually impossible to prove, but he does offer two pieces of evidence to back up his assertion. The first uses data from the 1993 General Sociology Survey, conducted by the National Opinion Research Center at the University of Chicago. The 1,500 respondents were asked to rate 18 genres of music on a scale of 1 (strongly dislike) to 5 (strongly like).

Their verbal intelligence was measured by a test in which they selected a synonym for a word out of five candidates. "Verbal intelligence is known to be highly correlated with general intelligence," Kanazawa writes. He found that "net of age, race, sex, education, family income, religion, current and past marital status and number of children, more intelligent Americans are more likely to prefer instrumental music such as big band, classical and easy listening than less-intelligent Americans." In contrast, they were no more likely to enjoy the other, vocal-heavy genres than those with lower intelligence scores.

A similar survey was given as part of the British Cohort Study, which includes all babies born in the U.K. the week of April 5, 1970. In 1986, when the participants were 16 years old, they were asked to rate their preference for 12 musical genres. They also took the same verbal intelligence test.

Like the Americans, the British teens who scored high marks for intelligence were more likely than their peers to prefer instrumental music, but no more likely to enjoy vocal selections.

Now, Beethoven symphonies are far more complex than pop songs, so an obvious explanation for these findings is that smarter people crave more complicated music. But Kanazawa doesn't think that's right. His crunching of the data suggests that preference for big-band music "is even more positively correlated" with high intelligence than classical compositions.

"It would be difficult to make the case that big-band music is more cognitively complex than classical music," he writes. "On the other extreme, as suspected, preference for rap music is significantly negatively correlated with intelligence. However, preference for gospel music is even more strongly negatively correlated with it. It would be difficult to make the case that gospel is less cognitively complex than rap."

His final piece of evidence involves Wagner and Verdi. "Preference for opera, another highly cognitively complex form of music, is not significantly correlated with intelligence," he writes. This finding suggests the human voice has wide appeal, even when the music is intellectually challenging.

Kanazawa's thesis is certainly debatable. For one thing, it implies highly intelligent people are more likely to appreciate such banal instrumental genres as smooth jazz and musak. Kenny G does not, as a rule, perform at Mensa meetings.

But the findings could serve as a marketing tool for an art form that is struggling in an era of pop dominance. If you want to entice people to sample the symphony, there are worse slogans than *Brainiacs Prefer Brahms.*

http://www.miller-mccune.com/culture-society/classical-music-linked-to-high-intelligence-27959/

Dietary Guidelines Include a Helping of Politics

Every five years, the U.S. government bravely tries to nudge Americans toward a healthier diet while not ticking off purveyors of less-desirable foods.

By Emily Badger

If it's not possible for the USDA to truly stand up for your cholesterol count and the cattle ranchers of America at the same time, should it really be in the business of producing dietary guidelines?

The U.S. Department of Agriculture and the Department of Health and Human Services this week released the latest edition of the "Dietary Guidelines for Americans," a collection of largely common-sense nutrition advice (drink more water, switch to fat-free milk, eat more fruits and vegetables) that every five years produces cackles from the food industry.

This year, the Peanut Institute is pleased. The Salt Institute is not. The American Meat Institute — well, it's spinning the latest emphasis on "lean" meat and poultry as a positive.

In the middle of all this, the USDA in particular is caught in an awkward spot, putting the government's seal of approval on some foods over others.

"You seem to be ducking all the meat questions we've had," pressed a reporter on a conference call this week with Agriculture Secretary Tom Vilsack, who then proceeded to duck the next one. Vilsack was more interested this week in talking up the advice that Americans eat more fish than the unspoken notion that you might decrease your meat intake in order to do that.

"The guidelines and the food guide have very long histories of reflecting the dual mission of the Department of Agriculture," said New York University professor Marion Nestle, "which is on the one hand to promote American agriculture products, do everything it can to sell more of them and, on the other hand, to advise the public about diet and health."

In other words, the entire exercise of producing dietary guidelines is fraught with an inherent conflict of interest. *The New York Times* highlighted the contradiction in November with an unsettling story ("While Warning About Fat, U.S. Pushes Cheese Sales") about a USDA marketing program that has been working to get more cheese into American diets — even helping Domino's invent a pizza with 40 percent more cheese — even as the USDA is leading the government's effort to fight epidemic obesity.

The new dietary guidelines, now in their seventh edition, raise a similar dilemma: If it's not possible for the USDA to truly stand up for your cholesterol count and the cattle ranchers of America at the same time, should

it really be in the business of producing dietary guidelines? Could another government agency do the job better? Should government even be doing this at all?

The Department of Agriculture began issuing food guides in the early 20th century. For more than 50 years, the advice focused on what Americans needed to eat *more* of to have nutritious diets. But by the 1970s, federal welfare programs had helped ease nearly all Americans out of abject poverty and malnutrition, and a different problem was developing throughout the country: chronic illnesses such as diabetes and heart disease, which were increasingly linked by scientists to diet.

Government, for the first time, had to figure out how to start talking about eating *less*.

In 1977, the Senate Select Committee on Nutrition and Human Needs released a report advising Americans to consume less red meat.

"It was indescribably controversial," said Nestle, who's written several influential books on food politics. "There were congressional hearings. There were headlines in newspapers. It was just beyond-belief controversial — the idea that a government committee would be suggesting that people eat less meat."

The year 1977 was the last time the federal government ever said this.

"The committee had to change the report by the end of the year, revise it," Nestle said. "And that's when the euphemisms started."

They have continued right through the newest guidelines, which will be followed a few months from now with an update of the government's equally contentious food pyramid. Now, when the government wants to encourage us to eat more of something, officials identify that food by name ("fish"). When they want us to eat less of something, they instead talk in nutrient-speak: Eat less *saturated fat* and *cholesterol* (which happen to enter the American diet primarily through meat and diary products).

"No industry wants to be told that people are supposed to be eating less of its products, and they all complain bloody murder," Nestle said. "And because of the way our political system works, they fund election campaigns."

So why even bother with the treacherous exercise? Nestle, who sat on the scientific advisory committee that helped update the guidelines in 1995, believes they're important even if they're flawed. Most Americans may not do their weekly meal planning with the aid of the USDA, but these guides govern, in a sense, how the federal government serves food, whether through school lunch reimbursement or food assistance programs.

Nestle thinks the National Academies' Institute of Medicine might have less of a conflict in producing the guidelines. But advisers there, still only human, she points out, may ultimately be subject to the same pressures.

"The idea that these are science-based is only partially true — they're science-based as modified by concerns of the impact of the guidelines on the food industry," she said. "As long as corporations are permitted to fund election campaigns, we'll never have dietary guidelines that are truly science-based, or based as much on science as they can be."

http://www.miller-mccune.com/politics/dietary-guidelines-include-a-helping-of-politics-28002/

Truly Smart Cars May Start Chatting With Each Other

Highway administrators say car-mounted Wi-Fi system could let cars and trucks gossip with each other on the road, dramatically improving safety and efficiency.

By Emily Badger

Transportation researchers are test driving ideas to improve vehicle safety, looking at car-mounted Wi-Fi systems that could let cars and trucks talk to each other to prevent collisions before they happen. (Department of Transportation)

Transportation officials and carmakers for the past 50 years have been steadily improving the "crashworthiness" of vehicles. They've mandated seat belts, added air bags and electronic stability control. If you get in an accident today, chances are you — and even your car — will emerge in much better shape than you would have a half-century ago.

"We've had all these great improvements to the vehicle structure and mechanisms, and we've taken that about as far as it can go — our cars are excellent, very safe," said John Augustine, managing director of the Intelligent Transportation Systems Joint Program Office inside the Department of Transportation's Research and Innovative Technology Administration.

Now, he and many DOT researchers believe we're about to enter a new phase in transportation safety. If the last 50 years were about mitigating crashes, in the next 50, technology could enable us to actually avoid them — and revolutionize in the process how we get around using all types of transportation.

Despite all the seat belts and air bags, more than 30,000 people died in road accidents in the U.S. in 2009. A report released in October by the National Highway Traffic Safety Administration predicted that this new technology — where, in DOT's vision, millions of vehicles on the road "talk to each other" through a kind of advanced Wi-Fi — could potentially address 81 percent of the light-vehicle crashes currently involving unimpaired drivers.

"This may be the one thing we all do in our careers that really makes a difference in society," Robert Bertini, RITA's deputy administrator, predicted to a ballroom full of "intelligent transportation" professionals at this week's annual Transportation Research Board conference in Washington.

The new technology would rely on Dedicated Short-Range Communications, a wireless connection with a 1-mile radius that is both faster and more secure than traditional Wi-Fi. Vehicles with the technology could communicate with each other in real time about everything from upcoming icy roads to approaching vehicles

in a driver's blind spot. Emergency responders could be notified the moment an airbag deploys. Instead of waiting to learn about a distant accident through the chain-reaction of brake lights illuminated in front of you, your car could automatically warn you the moment a nearby crash occurs (the system would not, however, push the brakes for you).

Once vehicles are communicating with each other and with infrastructure like stop lights, road signs and work zones, the technology has implications beyond safety. Officials could manage traffic flow more efficiently. Transit riders could track bus arrivals in real time. Drivers could plot routes with the smallest carbon footprint given traffic conditions. Your cruise control might learn to work in sync with the other cars on a crowded highway.

Or, consider this: If you're approaching a lonely, late-night intersection with a traffic light poised to turn red, it might sense your arrival and hold the green for you.

"Now you have a smart transportation environment, a smart network," Augustine said. "The cars are sensing one another, they're sensing the infrastructure, the infrastructure is sensing people, pedestrians, bicycles, motorcyclists. You have this very advanced sensor network through a very inexpensive kind of signal."

Augustine's office will spend the next two years researching the technology as the National Highway Traffic Safety Administration prepares to decide in 2013 if the federal government should regulate the technology and mandate it in future vehicles. Researchers don't yet know, for example, how drivers will react to the system. Should they be alerted of approaching dangers by an audio warning or a seat vibration? Could the data be repackaged by third parties into handheld mobility and environmental applications while ensuring those tools don't contribute to one of the main problems officials are trying to solve — distracted driving?

The DOT is largely focused on the technology's safety implications, but officials want to make the anonymous data that's routed through the system available to other researchers in an open-source platform that would allow anyone to come up with application ideas Augustine and his colleagues haven't even thought of yet.

In an atmosphere where public acceptance is as crucial as engineering solutions, Augustine stresses that the system isn't designed to track you or to help law enforcement dole out speeding tickets. "We know that privacy is a major concern, so we've factored that into the technical solution," he said.

It's clear that car companies and innovative businesses could spin new products from the data — and many are already working on the concept, but Augustine adds that government needs to help get the technology off the ground.

"The role of government on the safety side is pretty clear," he said. "And if we're going to spend all the time and energy and investment to put those signals out there and do the data collection on the safety side, why don't we warehouse it and make it available to everyone else?"

http://www.miller-mccune.com/culture-society/truly-smart-cars-may-start-chatting-with-each-other-27739/

Tiger Moms: The Benefits of Eating Bitterness

A Western mother sending her children to public school in Shanghai comes down firmly on both sides of the debate about author Amy Chua and Tiger Moms.

By Anna Greenspan

A Western mother living abroad in China offers her take on the Tiger Mother. (somethingway / istockphoto.com)

Over the past weeks, since the publication of Amy Chua's *Battle Hymn of the Tiger Mother*, the ongoing, ever-intensifying debate about China's rise and American decline has reached fever pitch.
The excerpt that ran in *The Wall Street Journal* has now received more than 7,500 comments, more than any other article in the history of WSJ.com. Reviews, interviews and commentary are everywhere, and the book made it to No. 3 on the Amazon best-seller list. In their outrage most reviewers have ignored the fact that the book is extremely well written. *Battle Hymn* conveys a tone of deadpan self-mockery that is laugh-out-loud funny and, instead of being preachy, is riddled with self-doubt.
I loved the book. As a Western mother living in Shanghai and sending my kids to a local Chinese school, for some time, I have been thinking about the contentious issue of cultural differences in parenting styles that Chua bravely raises.
Her main point is that culture matters. Those familiar with her work will recognize the theme. "Ethnicity," she writes, is "my favorite thing to talk about." *Battle Hymn* can be read as a companion to her first book *World on Fire*, which focuses on the market domination of ethnic minorities — Chinese in Southeast Asia, Jews in Russia, Ibos in Nigeria, etc. — in order to explore the relationship between ethnicity and achievement as well as the ethnic hatred that such achievement spawns.
When talking about parenting, Chua is careful to qualify her comments on the differences between Western and Chinese culture. There are, she writes, "same-sex parents, Orthodox Jewish parents, single parents, ex-hippie parents, investment banker parents and military parents. None of these 'Western' parents necessarily see eye to eye." There are also white working-class fathers as well as Korean, Indian, Jamaican, Irish and Ghanaian parents who all qualify as Chinese mothers. "You could be a Chinese mother," Chua told Comedy Central's Stephen Colbert.
There are also many ethnically Chinese parents who are not "Chinese mothers." Chua writes that these are mostly born in the West, but — as the response to *Battle Hymn* has made clear — there is a growing backlash

against Tiger Moms within China, especially among the upper classes. Just as many Americans suspect they should become more Chinese, many Chinese are questioning the stifling strictness of their parenting style. Just before the Chinese New Year, for example, *The New York Times* reported on an official in Hebei province who released a 32-point "play plan" to get kids to stop studying and have some fun during the holiday. Most of the Chinese parents I know in Shanghai are eagerly becoming more Western.

Still, as anyone immersed in Chinese culture realizes, substantial cultural differences exist. "Despite our squeamishness about cultural stereotypes," writes Chua, "there are tons of studies out there showing marked and quantifiable differences between Chinese and Westerners when it comes to parenting."

One of the most striking elements of Chinese culture — and, for many, the most unnerving part of *Battle Hymn* — is the absolute value placed on grueling, often monotonous, hard work. In China, even elementary schools expect between two to three hours of homework a night. The ability to endure this hardship — the Chinese call it "*chi ku*" (eating bitterness) — is one of the most highly valued virtues. In China, a spoiled kid is described as "*pa ku, pa lei*" being afraid of bitter, tiring work.

The notion that learning should be fun is a very Western idea.

"Everything valuable and worthwhile is difficult," Chua yells at her daughter, expressing the typical Chinese belief. Westerners assume that being good at something means that it comes easily, most Chinese think that being good at something is the result of relentless hard work.

In China, therefore, little weight is given to the idea of natural talent and the contribution of genes is regularly dismissed. Chua herself pays little heed to her own daughter's remarkable genetic inheritance. As *National Review*'s Charles Murray points out, Chua graduated from Harvard, she and her husband are both professors at Yale, and her father — the children's grandfather — is famous for his work in nonlinear circuit theory and cellular neural networks. It's hardly surprising her children are smart.

The provocative aspect of this deep appreciation of hard work is the implicit accusation that Western-style parenting is lazy, indulgent and soft. To a certain extent this is undoubtedly true. The demands on a Chinese mother are severe. Personally, l readily admit that, at least sometimes, my kids are left to play on their own (just as Chua suspects) so I can "enjoy a glass of wine and go to a yoga class." Ayelet Waldman's spoof of Chua in the *Wall Street Journal* is titled "In Defense of the Guilty, Ambivalent, Preoccupied Western Mom."

Yet Chua also recognizes that Westerner's lax parenting style is rooted in a particular understanding of childhood. "I saw childhood as a training period, a time to build character and invest in the future," writes Chua. She contrasts this with the more joyful attitude of her Jewish mother-in-law, who treasured happiness and saw "childhood as something fleeting to be enjoyed."

Even amongst Chinese mothers, Chua is clearly a fanatic. Yet, what is most unnerving about *Battle Hymn* is the suspicion that her lunacy is justified.

Chua is surely correct that true self-confidence only comes with the discipline it takes to excel. The best defense of *Battle Hymn* came in the form of an open letter by Chua's oldest daughter Sophia, titled "Why I love my strict Chinese Mom." "We all desire to live a meaningful life," Sophia writes. Part of that is "knowing that you've pushed yourself, body and mind, to the limits of your own potential. If I died tomorrow, I would die feeling I've lived my whole life at 110 percent."

It's probably true that kids who aren't disciplined are bored and that most, given the choice to follow their passion, would spend the whole day playing video games. As Stephen Colbert told Chua, American mothers "think you're wrong but secretly think you might be right."

As a Westerner living in China, I find this confusion particularly acute. "Chinese mothers" are deeply admirable and, at the same time, limited in fundamental ways.

One of the most troubling aspects of raising kids in China is that the intense emphasis on hard work comes with a deep, obsessive competitiveness. Ask a Shanghai parent how their kids are doing, and they almost always respond with a list of rankings and awards. Chua is typically candid about this. Her choice of the violin for her second daughter — rather than the gamelan gong as her mother-in-law suggests — is based in the fact that she "fetishizes difficulty and accomplishment," likes clear goals and "clear ways of measuring success." She chose the Suzuki method because "the bottom line is that some kids go through the Suzuki *books much faster than others*."

This extreme competitiveness explains why all the activities Chua insists on are done solo. Gold medals mean most when they are won on your own. Yet, in fiercely denying any activity that involves collectivity — sports or plays for example — the Tiger Mom denies precisely what many believe matters most.

Chua gives awful parenting advice, writes one blogger, since group activities — which teach people to work together and can foster leadership skills — matter far more than solo activities like piano or violin.
Indeed, mainland Chinese are notoriously bad at teamwork. Thirty years after Reform and Opening, many Chinese companies still bring in their top managers from outside. Success everywhere rests more on mastering social dynamics than on any particular intelligence or skill and yet, the fine — and sometimes vicious — art of socializing plays almost no part in Chua's childhood training.
"What I used to dread most," writes Chua, "was when other parents invited [us] over for a *playdate*. Why why why this terrible Western institution?" In protecting her daughters from the intricacies of social life, argues columnist David Brooks, Chua has shielded her daughters from the most difficult childhood lesson of all.
The fear that motivates Chua is generational decline. The "three generation rule" she worries about is well known in China. Here, too, it is often discussed with relation to immigrant life. Today's China is host to a vast internal migration as millions transition from rural to urban life. Many are concerned that while China's first-generation migrants are good at eating bitterness (they work extremely hard often under very harsh conditions), their own children or children's children seem "soft and entitled."
These second- and third-generation migrants have begun to protest their situation. Their discontent, ultimately, is a vital challenge to the Chinese state.
Many Westerners, especially Americans, view this rebelliousness in a positive light. This type of reader will think Sophia "the good daughter" right in suspecting that Lulu, the younger and more defiant child, is the real heroine of the book. There are, of course, dangers in valorizing the rebel — disrespect, violence and failure among them. But China's creative deficit is also bred from the fact that it has too few who subvert authority. Innovation, as everyone knows, rests on the willingness to color outside the lines.
Chua worries that those who are overindulged will turn out be "losers," but what really does that mean?
For me, the most alien aspect of the "Chinese mother" is that while most people's lives are governed by random chance, they approach their children with the seemingly unquestioning presumption that they know exactly what the future will bring. Many Chinese have a clear idea about their child's ideal career path almost from birth. Most have an almost total lack of flexibility in their notion of success. I have Chinese-American students who battle their parents over the choice to major in marketing rather than finance. Still, it is China that is on the rise …
Despite what her critics say, Chua does not preach or presume to know that the Chinese mother is always right. Her memoir is plagued with uncertainty. In this way, *Battle Hymn* raises fundamental and difficult questions. What is the right style of parenting? What do we want for our kids? What counts as a successful life? Most would concur with Chua's conclusion that the ideal is some balance between Chinese and Western styles. But mediating deep cultural differences is an extremely difficult task. In forcing us to think and talk about these issues Chua has helped us take a necessary step.

http://www.miller-mccune.com/culture/tiger-moms-the-benefits-of-eating-bitterness-28029/

Is It Hot in Here? Or Is the Climate Changing?

What's one way to convert climate change skeptics? By making them sweat.

By Tom Jacobs

For climate change skeptics, apparently, feeling is believing. New research suggests to convert someone dubious of climate change statistics, you need to turn up the heat — literally. (GChutka / istockphoto.com)

How do you get people to understand that climate change is occurring? The question frustrates scientists and policymakers, who face a disbelieving public prone to discounting discomforting data.

A newly published study suggests one answer is to set aside the charts and statistics in favor of a more visceral approach. To put it simply: If you want to convert a skeptic, turn up the thermostat.

Jane Risen of the University of Chicago and Clayton Critcher of the University of California, Berkeley, provide evidence that belief in global warming increases along with the temperature one is currently experiencing. The researchers attribute this to a phenomenon they call "visceral fit."

"We suggest that while experiencing a visceral state, people will judge future states of the world that fit with that experience to be more likely," they write in the *Journal of Personality and Social Psychology*. As they see it, uncomfortable feelings of warmth stimulate "fluent mental representations" of heat, which give "an inference of validity" to arguments the planet is warming.

Risen and Critcher describe seven studies that support and refine this thesis. In the first, 67 American university students "were taken outside under the pretense of judging the height of several campus landmarks," they write. The exercise occurred on several days in September and October, when the temperature ranged from 49 to 89 degrees.

The students filled out questionnaires in which they voiced their views on several political topics, including their degree of skepticism regarding climate change. They also reported their ideological leanings.

"We found that ambient temperature significantly predicted the belief in the validity of global warming, with participants reporting greater belief on warmer days," Risen and Critcher report. "In fact, the effect of temperature was as strong as ideology, and was not qualified by it. Thus, outside temperature influenced liberals and conservatives similarly."

But was this really a visceral response or an intellectual exercise in which some students (admittedly not exercising sophisticated analytical skills) felt warm and jumped to the conclusion the planet is heating up? To find out, the researchers essentially repeated the experiment, but indoors.

In the second study, 84 students completed the same survey while sitting in a small heated cubicle. For half of them, the cubicle was heated with a space heater for 15 minutes before their arrival, raising the air temperature from a comfortable 73 degrees to a toasty 81 degrees.

Those eight degrees made a difference: "Participants who responded in the heated cubicle believed global warming was more of a fact than those who responded in the control cubicle," the researchers report. Even in an indoor environment, where the temperature was controlled by humans, "people believed more in global warming when they were made hot than when they were not."

"As people tried to imagine the hot world implied by global warming, these mental images were simulated more fluently for those who were currently warm, which led to the inference that this hot world was more likely," the researchers conclude. As William James understood a century ago, bodily sensations, emotions and thoughts are inextricably linked.

While the researchers don't mention it, their work appears to reveal a tragic irony. Thanks to our use of greenhouse gas-emitting energy supplies, we now spend our summers in air-conditioned buildings and cars, which makes it harder for us to comprehend, on a visceral level, the reality of a warming world. Without such a sense, dire scenarios seem implausible and easy to dismiss.

Breaking this circle will not be easy, but this research provides scientists and educators valuable clues as to how it might be done.

"What makes future events feel more real is not necessarily well-conducted research or impressive meta-analyses that speak to the event's likelihood of occurrence," Risen and Critcher write, "but factors that facilitate the ability to picture what the future event would look and feel like." They add that facilitating that sort of imaginative leap may be the key to "belief formation and acceptance."

So if you find yourself arguing about climate change with tea partiers, you might want to meet them on their own terms and offer them some tea.

Serve it piping hot.

http://www.miller-mccune.com/culture-society/is-it-hot-in-here-or-is-the-climate-changing-27710/

Polar Bear Births Could Plummet With Climate Change

Researchers have linked declining litter sizes in polar bears with loss of sea ice. (Credit: iStockphoto)

ScienceDaily (Feb. 8, 2011) — University of Alberta researchers Péter Molnár, Andrew Derocher and Mark Lewis studied the reproductive ecology of polar bears in Hudson Bay and have linked declining litter sizes with loss of sea ice.

The researchers say projected reductions in the number of newborn cubs is a significant threat to the western Hudson Bay polar-bear population, and if climate change continues unabated the viability of the species across much of the Arctic will be in question.

Using data collected since the 1990s researchers looked at the changing length of time Hudson Bay is frozen over (the polar bear's hunting season) and the amount of energy pregnant females can store up before hibernation and birthing.

An early spring-ice breakup reduces the hunting season making it difficult for pregnant females to even support themselves, let alone give birth to and raise cubs. Pregnant polar bears take to a maternity den for up to eight months and during this time no food is available.

In the early 1990s, researchers estimate, 28 per cent of energy-deprived pregnant polar bears in the Hudson Bay region failed to have even a single cub. Researchers say energy deprived pregnant females will either not enter a maternity den or they will naturally abort the birth.

Using mathematical modeling to estimate the energetic impacts of a shortened hunting season, the research team calculated the following scenarios:

If spring break up in Hudson Bay comes one month earlier than in the 1990s, 40 to 73 per cent of pregnant female polar bears will not reproduce.

If the ice breaks up two months earlier than in the 1990s, 55 to a full 100 per cent of all pregnant female polar bears in western Hudson Bay will not have a cub.

The polar-bear population of western Hudson Bay is currently estimated to be around 900 which is down from 1,200 bears in the past decade.

The number of polar bears across the Arctic is estimated to be between 20,000 and 25,000.

The research team says because the polar bears of Hudson Bay are the most southerly population they are the first to be affected by the global-warming trend. However, they say that if temperatures across the Arctic continue to rise, much of the global population of polar bears will be at risk.
The research will be published in *Nature Communications*, Feb. 8

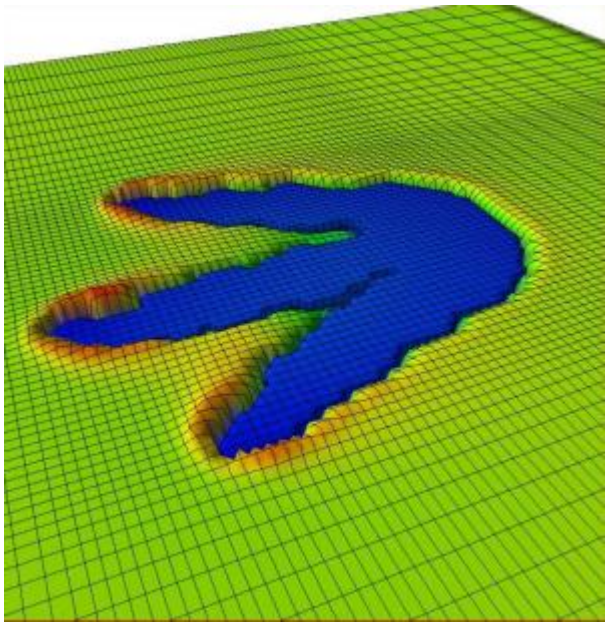
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of Alberta**, via EurekAlert!, a service of AAAS.

Journal Reference:

1. Péter K. Molnár, Andrew E. Derocher, Tin Klanjscek, Mark A. Lewis. **Predicting climate change impacts on polar bear litter size**. *Nature Communications*, 2011; 2: 186 DOI: 10.1038/ncomms1183

http://www.sciencedaily.com/releases/2011/02/110208112647.htm

Secrets of Dinosaur Footprints Revealed, Thanks to 'Goldilocks'



A computer model of a three-toed dinosaur track. (Credit: Image courtesy of Dr. Peter L. Falkingham, University of Manchester)

ScienceDaily (Feb. 3, 2011) — Terrain thought to be ruled by only the largest dinosaurs to inhabit Earth could have in fact been home to dozens of other creatures, ground-breaking research from The University of Manchester has found.

Writing in the journal of the Royal Society *Interface*, Dr. Peter Falkingham has discovered that dinosaurs only created lasting footprints if the soil conditions were perfect to do so -- and entirely depending on the animal's weight.

Dubbed the 'Goldilocks Effect' -- as all conditions have to be 'just right' for a print to be created -- this work could help to bring ancient environments to life, by showing how a great number of animals can walk over an area, but only a few leave behind tracks.

The findings mean that hugely-significant prehistoric dinosaur track sites, such as Paluxy River in Texas, USA, or Fumanya, Spain could have been host to a much larger number of dinosaurs and other animals than the tracks themselves show.

Dr. Falkingham, from the University's School of Earth, Atmospheric and Environmental Sciences, led a team using detailed computer modeling to recreate the process of large dinosaurs making footprints in different types of mud.

The team incorporated scientists from a range of disciplines, including vertebrate palaeontologist Dr. Phil Manning and Geotechnical engineer Dr. Lee Margetts, both from The University of Manchester, and biomechanicist Dr. Karl Bates (University of Liverpool).

By using computer modeling to simulate dinosaurs making tracks, the scientists were able for the first time to run dozens of simulations in order to systematically change the conditions of the mud.

As dinosaurs ranged vastly in weight, from Brachiosaurus, weighing around 30 tonnes, to Compsognathus, which was the size and weight of a chicken, Dr. Falkingham worked out that only the heaviest creatures would leave prints in certain mud conditions.

Equally, in other areas where the mud was deep and soft, only lighter, nimbler dinosaurs would be able to walk over it and therefore leave prints; larger animals would become stuck and die.

These insights give palaeontologists the chance to re-evaluate the ecosystems which existed more than 100 million years ago.

Dr. Falkingham said: "By using computer modeling, we were able to recreate the conditions involved when a 30-tonne animal makes a track.

"That's very hard to do with physical modeling, more so when you need to do it 20 times in 20 different types of mud.
"But the real advantage of computer modeling is that everything is controllable. We were able to ensure that in every simulation we could look at the effects of each variable (for instance, the shape of the foot, or the weight of the animal) independently.
"As with most scientific papers, this isn't the end of research, this is the beginning.
"Now we can use this "Goldilocks" effect as a baseline for exploring more complicated factors such as the way dinosaurs moved their legs, or what happens to tracks when a mud is drying out."
In Paluxy River, site of one of the most famous sets of dinosaur footprints which seem to show a sauropod being chased by a carnivorous theropod, there are only footprints recording large dinosaurs.
But Dr. Falkingham's findings suggest that many more species probably lived there, walking over the same mud, but their footprints either made no impression or have disappeared over time.
The computer method was based on a technique common in engineering, known as finite element analysis. This method lets scientists simulate the deformation of a material under load. While in engineering this may be an airplane wing supporting the aircraft, Dr. Falkingham and his co-authors applied the method to mud supporting a dinosaur.

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

Journal Reference:

1. P. L. Falkingham, K. T. Bates, L. Margetts, P. L. Manning. **The 'Goldilocks' effect: preservation bias in vertebrate track assemblages**. *Journal of The Royal Society Interface*, 2011; DOI: 10.1098/rsif.2010.0634

http://www.sciencedaily.com/releases/2011/02/110203102024.htm

Change of Heart Keeps Bears Healthy While Hibernating

New research illustrates a complex series of changes that occur in grizzly bears' hearts as they hibernate. (Credit: iStockphoto/Dirk Freder)

ScienceDaily (Feb. 8, 2011) — Hibernating, it turns out, is much more complicated than one might think. Research published in the latest issue of the journal *Physiological and Biochemical Zoology* illustrates a complex series of changes that occur in grizzly bears' hearts as they hibernate. The changes guard against complications that could arise from greatly reduced activity.

A grizzly hibernates five to six months of the year. During that time, its heart rate slows drastically from around 84 beats per minute when active to around 19. "If a human heart were to slow down like this, you'd see very detrimental things happening," said Bryan Rourke, a professor at Cal State Long Beach who worked on the research with his graduate student, Nathan Barrows.

Such a slow beat causes blood to pool in the heart's four chambers. In a human, the increased pressure would cause the chambers to stretch out. The dilated muscle would be weaker and less efficient, leading ultimately to congestive heart failure.

"Bears are able to avoid this," Rourke said, "and we're interested in how they do it."

Barrows and Rourke worked with Lynne Nelson and Charles Robbins, researchers at Washington State University who have been studying bears for years. They operate a facility at Washington State where grizzlies have been raised since birth and acclimated to echocardiogram testing. Research at the facility is providing crucial insight into the mysteries of the hibernating heart.

Nelson and Robbins had previously shown that, during hibernation, the muscle of a bear's left ventricle stiffens to prevent it from stretching as blood accumulates. But the stiffening of the ventricle presents another problem. The left atrium, which pushes blood into the left ventricle, must then work against greater resistance. "The atrium is pushing against a brick wall," Rourke said. "We thought there must be some kind of mechanism to keep the atrial muscle from wearing itself out."

Using echocardiogram data from the captive bears at Washington State and tissue samples from wild bears, the researchers found that the atrium protects itself by weakening its beat.
Muscle contractions in the heart are controlled by a protein called myosin heavy chain. The protein comes in two varieties, alpha and beta. The alpha version produces a quicker but slightly weaker contraction compared to the beta. "We found that the muscle in the left atrium produces more alpha protein during hibernation, which results in a slightly weaker beat," Rourke said. "The lower force keeps the atrium from being damaged as it pushes against the stiffer ventricle."
When the bears emerge from hibernation, the protein ratio switches back and the atrial contraction returns to its original strength.
The researchers believe this is the first study to show a shift in myosin ratio in bears, and they hope the information might someday have an application for humans.
"Bears aren't a perfect model for humans, but the way in which a bear's heart can change could be helpful in understanding human disease," Rourke said. "It's a really interesting physiology."

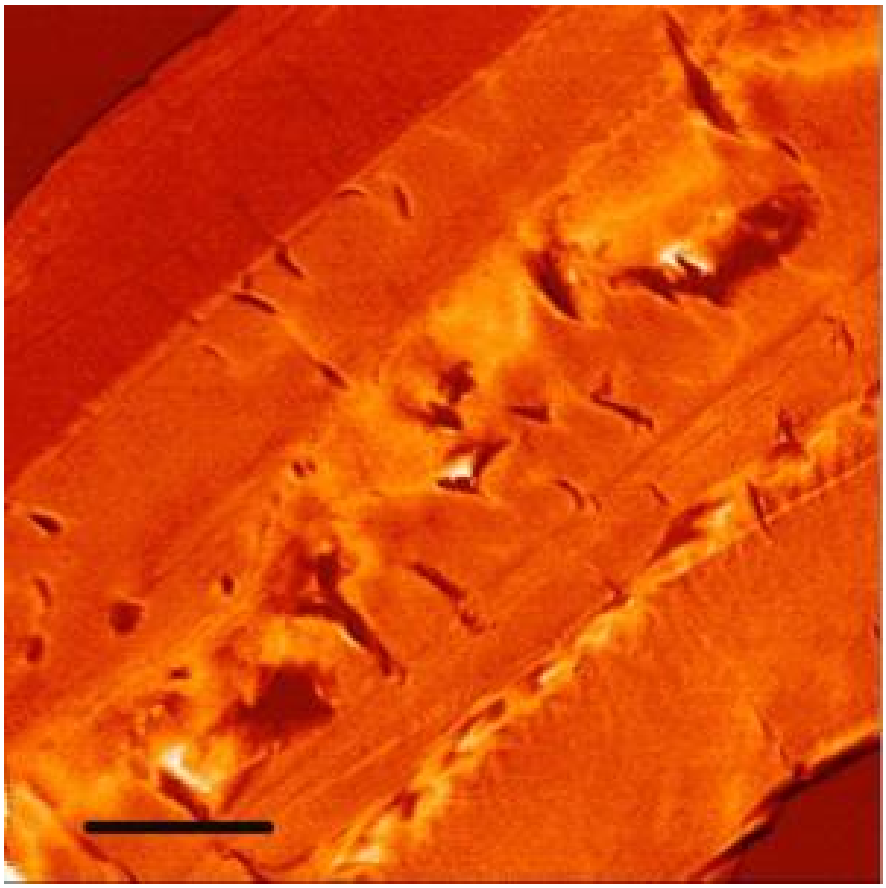
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of Chicago Press Journals**, via EurekAlert!, a service of AAAS.

Journal Reference:

1. N. D. Barrows, O. L. Nelson, C. T. Robbins, B. C. Rourke. **Increased Cardiac Alpha-Myosin Heavy Chain in Left Atria and Decreased Myocardial Insulin-Like Growth Factor (IGF-I) Expression Accompany Low Heart Rate in Hibernating Grizzly Bears**. *Physiological and Biochemical Zoology*, 2011; 84 (1): 1 DOI: 10.1086/657589

http://www.sciencedaily.com/releases/2011/02/110207142625.htm

Unexpected Exoskeleton Remnants Found in Paleozoic Fossils



High resolution X-ray Absorption Image mapping organic nitrogen abundance (brighter) in an ultra-thin section of modern scorpion cuticle. Scale bar = 5 µm (Credit: Image courtesy of Carnegie Institution)

ScienceDaily (Feb. 8, 2011) — Surprising new research shows that, contrary to conventional belief, remains of chitin-protein complex -- structural materials containing protein and polysaccharide -- are present in abundance in fossils of arthropods from the Paleozoic era. Previously the oldest molecular signature of chitin-protein complex was discovered in 25-million-year-old Cenozoic fossils and remnants of structural protein have also been discovered in 80 million-year-old Mesozoic fossils.

Carnegie's George Cody and an international team of scientists discovered relicts of protein-chitin complex in fossils of arthropods from the Paleozoic era. Their findings, published online by *Geology*, could have major implications for our understanding of the organic fossil record.

Among other common features, arthropods have exoskeletons, or cuticles. The outer portions of these cuticles are made up of a composite of chitin fibers, which are embedded in a matrix of protein. It is well known that chitin and structural protein are easily degraded by microorganisms and it has long been believed that chitin and structural proteins would not be present in fossils of moderate age, let alone in fossils dating back to the early Paleozoic.

Cody and his team studied fossil remains of a 310-million-year-old scorpion cuticle from northern Illinois and a 417-million-year-old eurypterid -- an extinct scorpion-like arthropod, possibly related to horseshoe crabs -- from Ontario, Canada. Using sophisticated analytical instrument at the Advanced Light Source facility, the research team measured the absorption spectra of low-energy X-rays by carbon, nitrogen, and oxygen in the fossils. These measurements were taken at a resolution on the order of 25 nanometers. The researchers showed that the majority of carbon, nitrogen and oxygen found in these fossils from the Paleozoic era were derived from a protein-chitin complex. Not surprisingly, the protein-chitin material was somewhat degraded, either by chemical processes or partial bacterial degradation.

Cody speculates that the vestigial protein-chitin complex may play a critical role in organic fossil preservation by providing a substrate protected from total degradation by a coating waxy substances that protect the arthropods from desiccation.

This research was supported by funds from National Aeronautics and Space Administration Astrobiology Institute and Massachusetts Institute of Technology. Some of the researchers were supported by donations to the American Chemical Society Petroleum Research Fund. The analyses reported here were performed at the Advanced Light Source at Lawrence Berkeley Laboratory -- a Department of Energy supported facility.

Story Source:

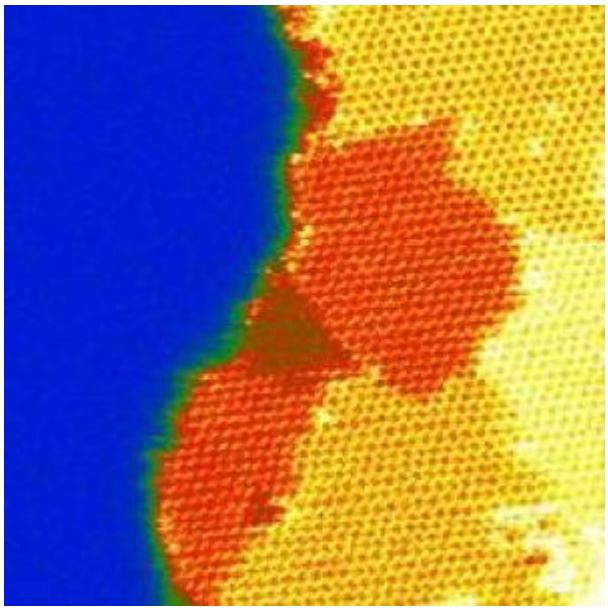
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Carnegie Institution**.

Journal Reference:

1. G. D. Cody, N. S. Gupta, D. E. G. Briggs, A. L. D. Kilcoyne, R. E. Summons, F. Kenig, R. E. Plotnick, A. C. Scott. **Molecular signature of chitin-protein complex in Paleozoic arthropods**. *Geology*, 2011; DOI: 10.1130/G31648.1

http://www.sciencedaily.com/releases/2011/02/110207115046.htm

Atom-Thick Sheets Unlock Future Technologies



Nanosheet imaged with an electron microscope (STEM). (Credit: Image courtesy of University of Oxford)

ScienceDaily (Feb. 8, 2011) — A new way of splitting layered materials, similar to graphite, into sheets of material just one atom thick could lead to revolutionary new electronic and energy storage technologies.

An international team, led by Oxford University and Trinity College Dublin scientists, has invented a versatile method for creating these one-atom thick 'nanosheets' from a range of materials using mild ultrasonic pulses, like those generated by jewellery cleaning devices, and common solvents. The new method is simple, fast, and inexpensive, and could be scaled up to work on an industrial scale.

The team publish a report of the research in this week's *Science*.

Each one-millimetre-thick layer of graphite is made up of around three million layers of graphene -- a flat sheet of carbon one atom thick -- stacked one on top of the other.

'Because of its extraordinary electronic properties graphene has been getting all the attention, including a recent Nobel Prize, as physicists hope that it might, one day, compete with silicon in electronics,' said Dr Valeria Nicolosi of Oxford University's Department of Materials, who led the research with Professor Jonathan Coleman of Trinity College Dublin. 'But in fact there are hundreds of other layered materials that could enable us to create powerful new technologies.'

Professor Coleman, of Trinity College Dublin, said: 'These novel materials have chemical and electronic properties which are well suited for applications in new electronic devices, super-strong composite materials and energy generation and storage. In particular, this research represents a major breakthrough towards the development of efficient thermoelectric materials.'

There are over 150 of these exotic layered materials -- such as Boron Nitride, Molybdenum disulfide, and Tungsten disulfide -- that have the potential to be metallic, semi-metallic or semiconducting depending on their chemical composition and how their atoms are arranged.

For decades researchers have tried to create nanosheets of these kind of materials as arranging them in atom-thick layers would enable us to unlock their unusual electronic and thermoelectric properties. However, all previous methods were extremely time consuming and laborious and the resulting materials were fragile and unsuited to most applications.

'Our new method offers low-costs, a very high yield and a very large throughput: within a couple of hours, and with just 1 mg of material, billions and billions of one-atom-thick graphene-like nanosheets can be made at the same time from a wide variety of exotic layered materials,' said Dr Nicolosi.

Nanosheets created using this method can be sprayed onto the surface of other materials, such as silicon, to produce 'hybrid films' which, potentially, enable their exotic abilities to be integrated with conventional

technologies. Such films could be used to construct, among other things, new designs of computing devices, sensors or batteries.
The work was conducted by a team including scientists from Oxford University, Trinity College Dublin, Imperial College London, Korea University, and Texas A&M University (USA).

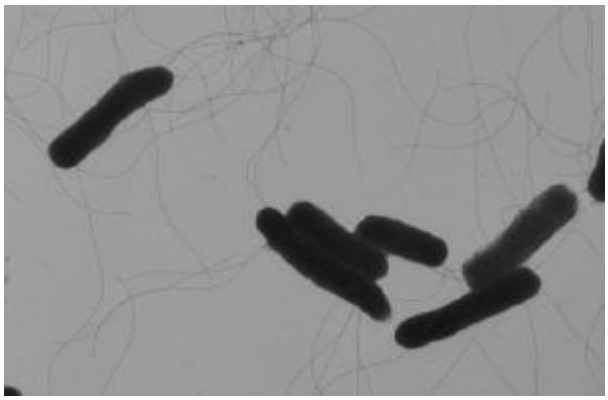
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of Oxford**.

Journal Reference:

1. J. N. Coleman, M. Lotya, A. O'Neill, S. D. Bergin, P. J. King, U. Khan, K. Young, A. Gaucher, S. De, R. J. Smith, I. V. Shvets, S. K. Arora, G. Stanton, H.-Y. Kim, K. Lee, G. T. Kim, G. S. Duesberg, T. Hallam, J. J. Boland, J. J. Wang, J. F. Donegan, J. C. Grunlan, G. Moriarty, A. Shmeliov, R. J. Nicholls, J. M. Perkins, E. M. Grieveson, K. Theuwissen, D. W. McComb, P. D. Nellist, V. Nicolosi. **Two-Dimensional Nanosheets Produced by Liquid Exfoliation of Layered Materials**. *Science*, 2011; 331 (6017): 568 DOI: 10.1126/science.1194975

http://www.sciencedaily.com/releases/2011/02/110203141818.htm

Researchers Turn Salmonella Into Antiviral Gene Therapy Agent



Shown is an image of Salmonella bacteria taken by an electron microscope. Researchers at UC Berkeley have turned this food-borne pathogen into an antiviral delivery agent. (Credit: Image by Sangwei Lu, UC Berkeley)

ScienceDaily (Feb. 7, 2011) — New experiments at the University of California, Berkeley, may one day lead to anti-viral treatments that involve swallowing *Salmonella* bacteria, effectively using one bug to stop another.

Researchers at UC Berkeley's School of Public Health have reprogrammed *Salmonella*, the same foodborne pathogen that can cause diarrhea, fever and abdominal cramps, to safely transport virus-stopping enzymes into cells without causing disease. Not only did this technique effectively treat mice infected with cytomegalovirus, it worked as an oral solution that was swallowed instead of injected.

Virologist Fenyong Liu teamed up with bacteriologist Sangwei Lu to develop the innovative technique, which is described in a study to be published online the week of Feb. 7 in the journal *Proceedings of the National Academy of Sciences*.

"A number of vaccines, including those for polio and smallpox, use live but weakened viruses to build up the immune system. But this is the first time anyone has successfully engineered bacteria for treatment of a viral infection," said Liu, a UC Berkeley professor at the Division of Infectious Diseases & Vaccinology.

The researchers said *Salmonella* was particularly appealing because it has evolved to survive the human digestive system, allowing it to be swallowed instead of injected or inhaled.

"This is the first gene therapy treatment for viral infection that can be taken by mouth, which is far more convenient to administer than an injection," said Lu, a UC Berkeley associate adjunct professor at the Division of Infectious Diseases & Vaccinology. "Moreover, there is already an attenuated strain of *Salmonella* with a decent track record for safety in humans since it is now used in the vaccine for typhoid (a disease caused by *Salmonella typhi*)."

Researchers know that ribozymes, enzymes that are able to target and cut specific RNA molecules, can be used to inactivate a pathogen's genes. But to do their work, ribozymes need to first get into the cells, and for that they need help.

It so happens that *Salmonella* is very good at invading cells, so the researchers found a way to use the bacterium as a vector for the RNase P ribozyme that could stop the gene activity of cytomegalovirus, or CMV.

CMV is in the same family of herpes viruses that causes cold sores, mononucleosis and chickenpox. CMV infections are generally mild among healthy individuals, but they can become deadly for people whose immune systems are compromised and are a leading viral cause of mental retardation in newborns.

Previous research by Liu and Lu showed that *Salmonella* could effectively sneak the anti-viral ribozymes into human cells infected with human cytomegalovirus and reduce the viral load of the cell cultures. This new study put the technique to the test in living mice.

As an added measure of safety, researchers took the attenuated strain of *Salmonella* and further mutated a gene that the bacteria needs to replicate. They tested the new mutant *Salmonella* strain in mice and confirmed that the mice did not get sick.

They then cloned the anti-viral ribozymes into a plasmid, or DNA molecules within the bacteria that can replicate. Among mice that had been infected with cytomegalovirus, those that had been given oral doses of the ribozyme-carrying *Salmonella* survived much better than mice that had not been treated or mice that had been given *Salmonella* carrying a defective version of the ribozyme. The treated mice lived at least 50 days after infection, whereas the mice in the other two groups died within 25 days after infection.

Moreover, the researchers found that the viral load of mice treated with the ribozyme-carrying *Salmonella* was 400- to 600-times lower than the viral load for mice given the defective ribozymes and for mice that were untreated.

The researchers pointed out that using bacteria instead of viruses as gene-therapy vectors has a number of advantages.

"Viruses can't replicate on their own; they must be grown in host cells," said Lu. "It is more challenging to grow host cells in a lab, and there is always the risk that those cells can be contaminated with unknown viruses. To grow bacteria, you only need to add some bacteria to a simple medium, and the next day you can have 100 billion bacteria ready to go. It's safer, easier and cheaper as a vector for gene therapy."

The researchers pointed to the potential for developing this technique into a range of gene-targeting therapeutics. "This study focused on the use of *Salmonella* and ribozymes to fight infections, but with more research, this method could eventually be used to treat other conditions as well, including cancer," said Liu.

Other UC Berkeley authors on the paper include lead author Yong Bai and Hao Gong, both post-doctoral researchers in infectious diseases; Hongjian Li, a former post-doctoral researcher in infectious diseases; and Gia-Phong Vu, a graduate student in comparative biochemistry.

The U.S. Department of Agriculture and the National Institutes of Health helped support this research.

Story Source:

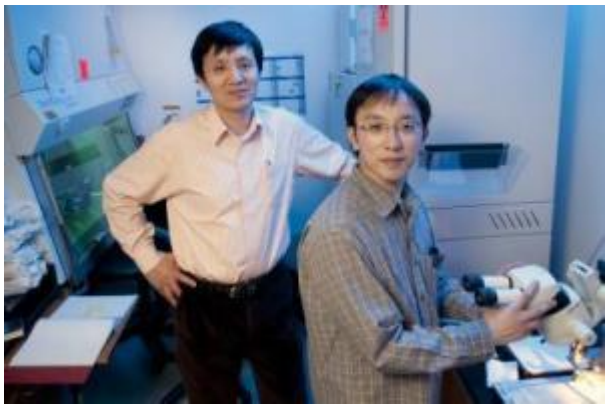
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of California - Berkeley**. The original article was written by Sarah Yang, Media Relations.

Journal Reference:

1. Yong Bai, Hao Gong, Hongjian Li, Gia-Phong Vu, Sangwei Lu and Fenyong Liu. **Oral delivery of RNase P ribozymes by Salmonella inhibits viral infection in mice**. *Proceedings of the National Academy of Sciences*, 2011; DOI: 10.1073/pnas.1014975108

http://www.sciencedaily.com/releases/2011/02/110207151210.htm

The Brain Knows What the Nose Smells, but How?



Professor Liqun Luo, left, in his lab with post doctoral fellow Kazunari Miyamichi who is the lead author on the paper to be published in Nature magazine. (Credit: L.A. Cicero, Stanford University News Service)

ScienceDaily (Feb. 7, 2011) — Mice know fear. And they know to fear the scent of a predator. But how do their brains quickly figure out with a sniff that a cat is nearby?

It's a complex process that starts with the scent being picked up by specific receptors in their noses. But until now it wasn't clear exactly how these scent signals proceeded from nose to noggin for neural processing.

In a study to be published in *Nature*, Stanford researchers describe a new technique that makes it possible to map long-distance nerve connections in the brain. The scientists used the technique to map for the first time the path that the scent signals take from the olfactory bulb, the part of the brain that first receives signals from odor receptors in the nose, to higher centers of the mouse brain where the processing is done.

"No one could trace signals across neural connections to a specific type of neuron at a specific location before," said biology Professor Liqun Luo. This is Luo's first study of the mouse olfactory system, but his lab has spent 10 years studying olfactory pathways in the fruit fly. Because mouse brains are so much larger and more complex that those of flies, Luo and postdoctoral researcher Kazunari Miyamichi had to develop an entirely new experimental technique.

These techniques can be used to do more than just study how mice smell. "The tools we've developed can be applied to trace neural connections of any part of the nervous system," Luo said. The tools could be used to understand how mouse brains process information from their other senses, or how the brain controls movement. The tools could also be adapted for use in rats and other mammalian species, he said.

To trace the neural pathways, the researchers injected mouse brains with two viruses, one after the other. The researchers first injected a low-grade virus into the higher centers of a mouse brain, where it infected nearby neurons.

This first virus left the neurons susceptible to infection by the second virus, which was injected two weeks later. The second virus -- fluorescent red in color -- was designed by collaborator Edward Callaway at the Salk Institute.

Genes introduced by the first virus allowed the next virus to infect its way from the higher brain to the olfactory bulb, going in the opposite direction of scent signals. By following the backward progress of the second virus, the scientists could identify the neurons in the olfactory bulb where the virus ended up, thanks to the red fluorescence.

The scientists then sliced each mouse brain into about 60 thin sections, and took photos of all of them through a microscope. They used a sophisticated algorithm to combine the images from 35 mice into a 3-D model of the olfactory bulb designed by graduate students Fernando Amat and Farshid Moussavi in Professor Mark Horowitz's electric engineering group. This allowed them to look for patterns between where the virus started in the higher brain centers and where in the olfactory bulb it finished its journey.

They found that most of the nerve pathways heading to the higher processing centers that direct the mice's innate like or dislike of certain odors, and trigger a response to them, originated from one region -- the top part of the olfactory bulb. This could explain how the mouse brain directs the animal's innate fear response to cat or fox urine.

This is in contrast to the neurons heading to the brain areas which process learned responses to odor. The neurons associated with learned responses are scattered all over the olfactory bulb, and their relative lack of organization could reflect their flexibility in allowing the mice to learn to avoid or be attracted to new smells.
The group also found that each neuron in the brain's higher centers receives signals from at least four neurons in the olfactory bulb, each of which receives input from a large number of like odor receptors. This progressive funneling and processing helps explain how the brain integrates the information from many different odors, Luo said.
In addition, he said, "There might be similar organizational principles in flies and mice, despite the evolutionary distance between them."
Luo said he will use the techniques in this study to take a more detailed look at other parts of the mouse olfactory bulb and brain, with the eventual goal of understanding how the brain processes specific odors. He said he was also working to improve the technique to track neurons across longer distances, allowing him to look in more detail at other pathways in the mouse nervous system.

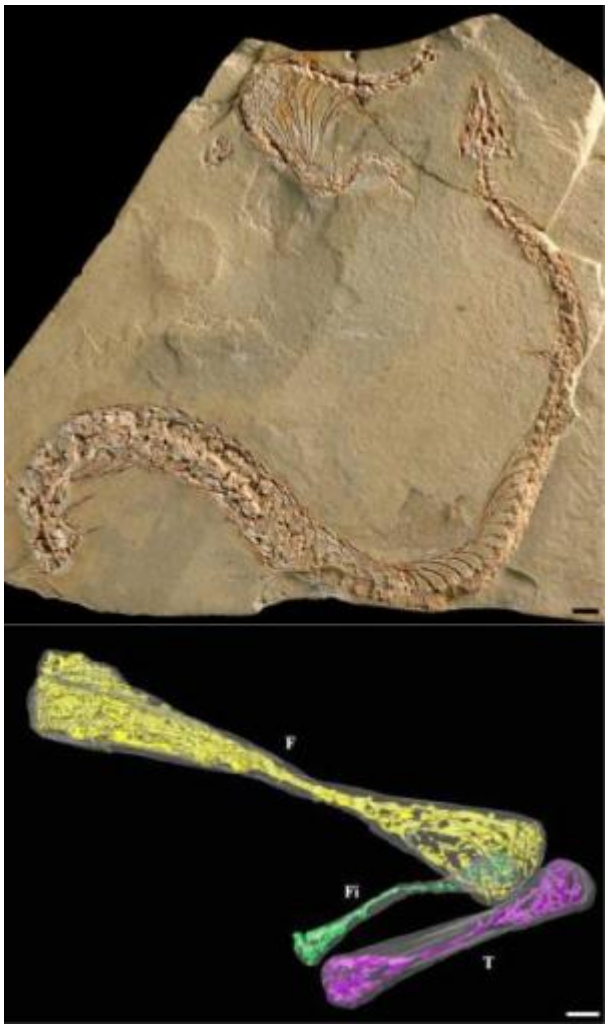
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Stanford University**. The original article was written by Sandeep Ravindran.

Journal Reference:

1. Kazunari Miyamichi, Fernando Amat, Farshid Moussavi, Chen Wang, Ian Wickersham, Nicholas R. Wall, Hiroki Taniguchi, Bosiljka Tasic, Z. Josh Huang, Zhigang He, Edward M. Callaway, Mark A. Horowitz, Liqun Luo. **Cortical representations of olfactory input by trans-synaptic tracing**. *Nature*, 2010; DOI: 10.1038/nature09714

http://www.sciencedaily.com/releases/2011/02/110204205511.htm

X-Rays Reveal Hidden Leg of an Ancient Snake: New Hints on How Snakes Were Getting Legless



Top: Photograph of Eupodophis descouensi, a fossil snake from the Cretaceous Period (95 million years ago) of Lebanon. The black scale bar at the bottom right equals 1 cm. Bottom: 3-D reconstruction from synchrotron X-ray images of the previously hidden second leg of Eupodophis. The bones are artificially colored to highlight the internal structure of the bone and show how the snake's leg grew. (Credit: A. Houssaye)

ScienceDaily (Feb. 7, 2011) — A novel X-ray imaging technology is helping scientists better understand how in the course of evolution snakes have lost their legs. The researchers hope the new data will help resolve a heated debate about the origin of snakes: whether they evolved from a terrestrial lizard or from one that lived in the oceans. New, detailed 3-D images reveal that the internal architecture of an ancient snake's leg bones strongly resembles that of modern terrestrial lizard legs.

The results are published in the Feb. 8, 2011 issue of the *Journal of Vertebrate Paleontology*.

The team of researchers was led by Alexandra Houssaye from the Museum National d'Histoire Naturelle (MNHN) in Paris, France, and included scientists from the European Synchrotron Radiation Facility (ESRF) in Grenoble, France, where the X-ray imaging was performed, and the Karlsruhe Institute of Technology (KIT), Germany, where a sophisticated technique and a dedicated instrument to take the images were developed.

Only three specimens exist of fossilised snakes with preserved leg bones. *Eupodophis descouensi*, the ancient snake studied in this experiment, was discovered ten years ago in 95-million-year-old rocks in Lebanon.

About 50 cm long overall, it exhibits a small leg, about 2 cm long, attached to the animal's pelvis. This fossil is key to understanding the evolution of snakes, as it represents an intermediate evolutionary stage when ancient snakes had not yet completely lost the legs they inherited from earlier lizards. Although the fossil exhibits just one leg on its surface, a second leg was thought to be concealed in the stone, and indeed this leg was revealed in full detail thanks to synchrotron X-rays.

The high-resolution 3-D images, in particular the fine detail of the buried small leg, suggest that this species lost its legs because they grew more slowly, or for a shorter period of time. The data also reveal that the hidden leg is bent at the knee and has four ankle bones but no foot or toe bones.

"The revelation of the inner structure of *Eupodophis* hind limbs enables us to investigate the process of limb regression in snake evolution," says Alexandra Houssaye.

The scientists used synchrotron laminography, a recent imaging technique specially developed for studying large, flat samples. It is similar to the computed tomography (CT) technique used in many hospitals, but uses a coherent synchrotron X-ray beam to resolve details a few micrometers in size--some 1000 times smaller than a hospital CT scanner. For the new technique, the fossil is rotated at a tilted angle in a brilliant high-energy X-ray beam, with thousands of two-dimensional images recorded as it makes a full 360-degree turn. From these individual images, a high-resolution, 3-D representaton is reconstructed, which shows hidden details like the internal structures of the legs.

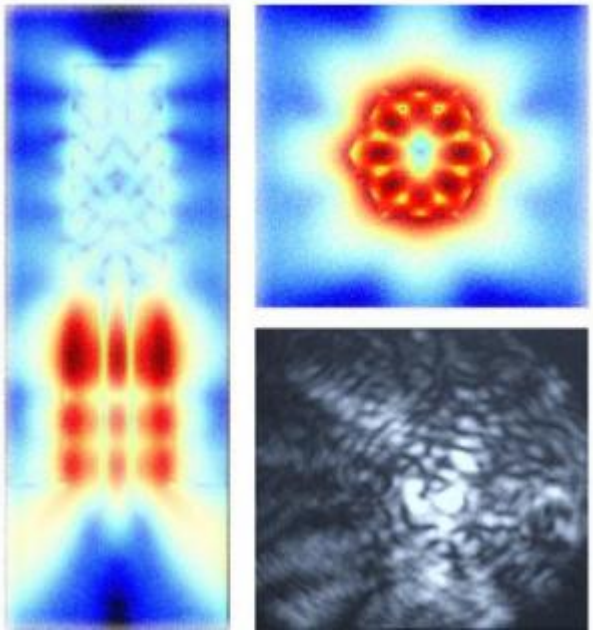
"Synchrotrons, these enormous machines, allow us to see microscopic details in fossils invisible to any other techniques without damage to these invaluable specimens," says Paul Tafforeau of the ESRF, a co-author of the study.

Story Source:

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

http://www.sciencedaily.com/releases/2011/02/110207142619.htm

Engineers Grow Nanolasers on Silicon, Pave Way for on-Chip Photonics



The unique structure of the nanopillars grown by UC Berkeley researchers strongly confines light in a tiny volume to enable subwavelength nanolasers. Images on the left and top right show simulated electric field intensities that describe how light circulates helically inside the nanopillars. On the bottom right is an experimental camera image of laser light from a single nanolaser. (Credit: Connie Chang-Hasnain Group)

ScienceDaily (Feb. 7, 2011) — Engineers at the University of California, Berkeley, have found a way to grow nanolasers directly onto a silicon surface, an achievement that could lead to a new class of faster, more efficient microprocessors, as well as to powerful biochemical sensors that use optoelectronic chips.

They describe their work in a paper to be published Feb. 6 in an advanced online issue of the journal *Nature Photonics*.

"Our results impact a broad spectrum of scientific fields, including materials science, transistor technology, laser science, optoelectronics and optical physics," said the study's principal investigator, Connie Chang-Hasnain, UC Berkeley professor of electrical engineering and computer sciences.

The increasing performance demands of electronics have sent researchers in search of better ways to harness the inherent ability of light particles to carry far more data than electrical signals can. Optical interconnects are seen as a solution to overcoming the communications bottleneck within and between computer chips.

Because silicon, the material that forms the foundation of modern electronics, is extremely deficient at generating light, engineers have turned to another class of materials known as III-V (pronounced "three-five") semiconductors to create light-based components such as light-emitting diodes (LEDs) and lasers.

But the researchers pointed out that marrying III-V with silicon to create a single optoelectronic chip has been problematic. For one, the atomic structures of the two materials are mismatched.

"Growing III-V semiconductor films on silicon is like forcing two incongruent puzzle pieces together," said study lead author Roger Chen, a UC Berkeley graduate student in electrical engineering and computer sciences. "It can be done, but the material gets damaged in the process."

Moreover, the manufacturing industry is set up for the production of silicon-based materials, so for practical reasons, the goal has been to integrate the fabrication of III-V devices into the existing infrastructure, the researchers said.

"Today's massive silicon electronics infrastructure is extremely difficult to change for both economic and technological reasons, so compatibility with silicon fabrication is critical," said Chang-Hasnain. "One problem is that growth of III-V semiconductors has traditionally involved high temperatures -- 700 degrees Celsius or more -- that would destroy the electronics. Meanwhile, other integration approaches have not been scalable."

The UC Berkeley researchers overcame this limitation by finding a way to grow nanopillars made of indium gallium arsenide, a III-V material, onto a silicon surface at the relatively cool temperature of 400 degrees Celsius.

"Working at nanoscale levels has enabled us to grow high quality III-V materials at low temperatures such that silicon electronics can retain their functionality," said Chen.

The researchers used metal-organic chemical vapor deposition to grow the nanopillars on the silicon. "This technique is potentially mass manufacturable, since such a system is already used commercially to make thin film solar cells and light emitting diodes," said Chang-Hasnain.

Once the nanopillar was made, the researchers showed that it could generate near infrared laser light -- a wavelength of about 950 nanometers -- at room temperature. The hexagonal geometry dictated by the crystal structure of the nanopillars creates a new, efficient, light-trapping optical cavity. Light circulates up and down the structure in a helical fashion and amplifies via this optical feedback mechanism.

The unique approach of growing nanolasers directly onto silicon could lead to highly efficient silicon photonics, the researchers said. They noted that the miniscule dimensions of the nanopillars -- smaller than one wavelength on each side, in some cases -- make it possible to pack them into small spaces with the added benefit of consuming very little energy

"Ultimately, this technique may provide a powerful and new avenue for engineering on-chip nanophotonic devices such as lasers, photodetectors, modulators and solar cells," said Chen.

"This is the first bottom-up integration of III-V nanolasers onto silicon chips using a growth process compatible with the CMOS (complementary metal oxide semiconductor) technology now used to make integrated circuits," said Chang-Hasnain. "This research has the potential to catalyze an optoelectronics revolution in computing, communications, displays and optical signal processing. In the future, we expect to improve the characteristics of these lasers and ultimately control them electronically for a powerful marriage between photonic and electronic devices."

The Defense Advanced Research Projects Agency and a Department of Defense National Security Science and Engineering Faculty Fellowship helped support this research.

Story Source:

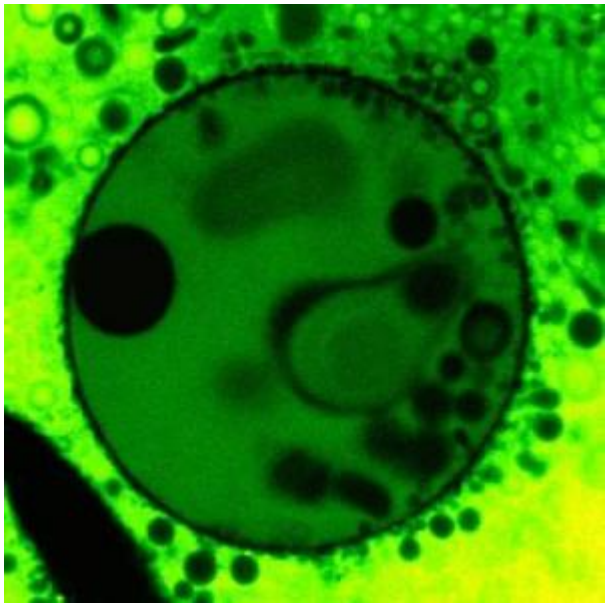
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of California - Berkeley**, via EurekAlert!, a service of AAAS.

Journal Reference:

1. Roger Chen, Thai-Truong D. Tran, Kar Wei Ng, Wai Son Ko, Linus C. Chuang, Forrest G. Sedgwick, Connie Chang-Hasnain. **Nanolasers grown on silicon**. *Nature Photonics*, 2011; DOI: 10.1038/nphoton.2010.315

http://www.sciencedaily.com/releases/2011/02/110206132906.htm

Clay-Armored Bubbles May Have Formed First Protocells: Minerals Could Have Played a Key Role in the Origins of Life



Fatty-acid liposomes compartmentalize inside a clay vesicle. (Credit: Photo courtesy of Anand Bala Subramaniam, Harvard School of Engineering and Applied Sciences)

ScienceDaily (Feb. 7, 2011) — A team of applied physicists at Harvard's School of Engineering and Applied Sciences (SEAS), Princeton, and Brandeis have demonstrated the formation of semipermeable vesicles from inorganic clay.

The research, published online in the journal *Soft Matter,* shows that clay vesicles provide an ideal container for the compartmentalization of complex organic molecules.

The authors say the discovery opens the possibility that primitive cells might have formed inside inorganic clay microcompartments.

"A lot of work, dating back several decades, explores the role of air bubbles in concentrating molecules and nanoparticles to allow interesting chemistry to occur," says lead author Anand Bala Subramaniam, a doctoral candidate at SEAS.

"We have now provided a complete physical mechanism for the transition from a two-phase clay-air bubble system, which precludes any aqueous-phase chemistry, to a single aqueous-phase clay vesicle system," Subramaniam says, "creating a semipermeable vesicle from materials that are readily available in the environment."

"Clay-armored bubbles" form naturally when platelike particles of montmorillonite collect on the outer surface of air bubbles under water.

When the clay bubbles come into contact with simple organic liquids like ethanol and methanol, which have a lower surface tension than water, the liquid wets the overlapping plates. As the inner surface of the clay shell becomes wet, the disturbed air bubble inside dissolves.

The resulting clay vesicle is a strong, spherical shell that creates a physical boundary between the water inside and the water outside. The translucent, cell-like vesicles are robust enough to protect their contents in a dynamic, aquatic environment such as the ocean.

Microscopic pores in the vesicle walls create a semipermeable membrane that allows chemical building blocks to enter the "cell," while preventing larger structures from leaving.

Scientists have studied montmorillonite, an abundant clay, for hundreds of years, and the mineral is known to serve as a chemical catalyst, encouraging lipids to form membranes and single nucleotides to join into strands of RNA.

Because liposomes and RNA would have been essential precursors to primordial life, Subramaniam and his coauthors suggest that the pores in the clay vesicles could do double duty as both selective entry points and catalytic sites.

"The conclusion here is that small fatty acid molecules go in and self-assemble into larger structures, and then they can't come out," says principal investigator Howard A. Stone, the Dixon Professor in Mechanical and Aerospace Engineering at Princeton, and a former Harvard faculty member. "If there is a benefit to being protected in a clay vesicle, this is a natural way to favor and select for molecules that can self-organize."

Future research will explore the physical interactions between the platelike clay particles, and between the liquids and the clay. The researchers are also interested to see whether these clay vesicles can, indeed, be found in the natural environment today.

"Whether clay vesicles could have played a significant role in the origins of life is of course unknown," says Subramaniam, "but the fact that they are so robust, along with the well-known catalytic properties of clay, suggests that they may have had some part to play."

Subramaniam and Stone's coauthors include Jiandi Wan, of Princeton University, and Arvind Gopinath, of Brandeis University.

The research was funded by the Harvard Materials Research Science and Engineering Center and supported by the Harvard Center for Brain Science Imaging Facility.

Story Source:

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

Journal Reference:

1. Anand Bala Subramaniam, Jiandi Wan, Arvind Gopinath, Howard A. Stone. **Semi-permeable vesicles composed of natural clay**. *Soft Matter*, 2011; DOI: 10.1039/C0SM01354D

http://www.sciencedaily.com/releases/2011/02/110207073744.htm

Brief Diversions Vastly Improve Focus, Researchers Find

A new study suggests taking brief mental breaks improves performance on a prolonged task. (Credit: iStockphoto/Izabela Habur)

ScienceDaily (Feb. 8, 2011) — A new study in the journal *Cognition* overturns a decades-old theory about the nature of attention and demonstrates that even brief diversions from a task can dramatically improve one's ability to focus on that task for prolonged periods.

The study zeroes in on a phenomenon known to anyone who's ever had trouble doing the same task for a long time: After a while, you begin to lose your focus and your performance on the task declines.

Some researchers believe that this "vigilance decrement," as they describe it, is the result of a drop in one's "attentional resources," said University of Illinois psychology professor Alejandro Lleras, who led the new study. "For 40 or 50 years, most papers published on the vigilance decrement treated attention as a limited resource that would get used up over time, and I believe that to be wrong. You start performing poorly on a task because you've stopped paying attention to it," he said. "But you are always paying attention to something. Attention is not the problem."

Lleras had noticed that a similar phenomenon occurs in sensory perception: The brain gradually stops registering a sight, sound or feeling if that stimulus remains constant over time. For example, most people are not aware of the sensation of clothing touching their skin. The body becomes "habituated" to the feeling and the stimulus no longer registers in any meaningful way in the brain.

In previous studies, Lleras explored the limits of visual perception over time, focusing on a phenomenon called Troxler Fading: when continual attention to a stationary object in one's peripheral vision can lead to that object's complete "disappearance" from view.

"Constant stimulation is registered by our brains as unimportant, to the point that the brain erases it from our awareness," Lleras said. "So I thought, well, if there's some kind of analogy about the ways the brain fundamentally processes information, things that are true for sensations ought to be true for thoughts. If sustained attention to a sensation makes that sensation vanish from our awareness, sustained attention to a thought should also lead to that thought's disappearance from our mind!"

In the new study, Lleras and postdoctoral fellow Atsunori Ariga tested participants' ability to focus on a repetitive computerized task for about an hour under various conditions. The 84 study subjects were divided into four groups:

- The control group performed the 50-minute task without breaks or diversions.
- The "switch" group and the "no-switch" group memorized four digits prior to performing the task, and were told to respond if they saw one of the digits on the screen during the task. Only the switch group was actually presented with the digits (twice) during the 50-minute experiment. Both groups were tested on their memory of the digits at the end of the task.
- The "digit-ignored" group was shown the same digits presented to the switch group during the task, but was told to ignore them.

As expected, most participants' performance declined significantly over the course of the task. But most critically, Lleras said, those in the switch group saw no drop in their performance over time. Simply having them take two brief breaks from their main task (to respond to the digits) allowed them to stay focused during the entire experiment.

"It was amazing that performance seemed to be unimpaired by time, while for the other groups performance was so clearly dropping off," Lleras said.

This study is consistent with the idea that the brain is built to detect and respond to change, Lleras said, and suggests that prolonged attention to a single task actually hinders performance.

"We propose that deactivating and reactivating your goals allows you to stay focused," he said. "From a practical standpoint, our research suggests that, when faced with long tasks (such as studying before a final exam or doing your taxes), it is best to impose brief breaks on yourself. Brief mental breaks will actually help you stay focused on your task!"

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. Atsunori Ariga, Alejandro Lleras. **Brief and rare mental 'breaks' keep you focused: Deactivation and reactivation of task goals preempt vigilance decrements**. *Cognition*, 2011; DOI: 10.1016/j.cognition.2010.12.007

http://www.sciencedaily.com/releases/2011/02/110208131529.htm

Fingerprint Makes Computer Chips Counterfeit-Proof

Digital fingerprint makes chips conterfeit-proof. (Credit: © Fraunhofer SIT)

ScienceDaily (Feb. 8, 2011) — Product counterfeiters are increasingly targeting chips and electronic components, with attacks on hardware modules becoming commonplace. Tailor-made security technology utilizes a component's individual material properties to generate a digital key. This provides components with an identity -- since their unique structure cannot be copied.

Fraunhofer researchers will be presenting a prototype at the embedded world Exhibition & Conference in Nuremberg from March 1 to 3.

Product piracy long ago ceased to be limited exclusively to the consumer goods sector. Industry, too, is increasingly having to combat this problem. Cheap fakes cost business dear: The German mechanical and plant engineering sector alone lost 6.4 billion euros of revenue in 2010, according to a survey by the German Engineering Federation (VDMA). Sales losses aside, low-quality counterfeits can also damage a company's brand image. Worse, they can even put people's lives at risk if they are used in areas where safety is paramount, such as automobile or aircraft manufacture. Patent rights or organizational provisions such as confidentiality agreements are no longer sufficient to prevent product piracy. Today's commercially available anti-piracy technology provides a degree of protection, but it no longer constitutes an insurmountable obstacle for the product counterfeiters: Criminals are using scanning electron microscopes, focused ion beams or laser bolts to intercept security keys -- and adopting increasingly sophisticated methods.

No two chips are the same

At embedded world, researchers from the Fraunhofer Institute for Secure Information Technology SIT will be demonstrating how electronic components or chips can be made counterfeit-proof using physical unclonable functions (PUFs). "Every component has a kind of individual fingerprint since small differences inevitably arise between components during production," explains Dominik Merli, a scientist at Fraunhofer SIT in Garching near Munich. Printed circuits, for instance, end up with minimal variations in thickness or length during the manufacturing process. While these variations do not affect functionality, they can be used to generate a unique code.

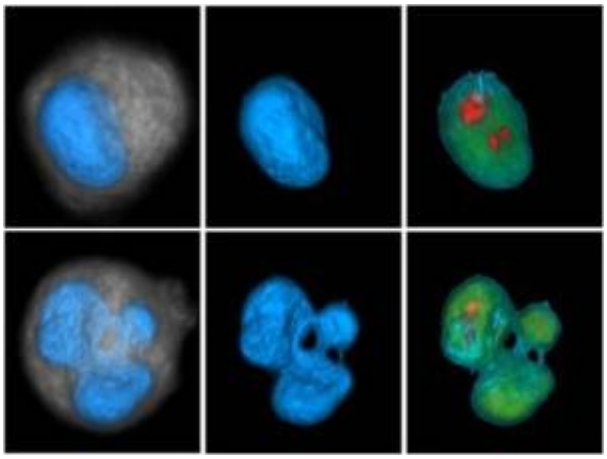
Invasive attacks destroy the structure

A PUF module is integrated directly into a chip -- a setup that is feasible not only in a large number of programmable semiconductors known as FPGAs (field programmable gate arrays) but equally in hardware components such as microchips and smartcards. "At its heart is a measuring circuit, for instance a ring oscillator. This oscillator generates a characteristic clock signal which allows the chip's precise material properties to be determined. Special electronic circuits then read these measurement data and generate the component-specific key from the data," explains Merli. Unlike conventional cryptographic processes, the secret key is not stored on the hardware but is regenerated as and when required. Since the code relates directly to the system properties at any given point in time, it is virtually impossible to extract and clone it. Invasive attacks on the chip would alter physical parameters, thus distorting or destroying the unique structure.
The Garching-based researchers have already developed two prototypes: A butterfly PUF and a ring oscillator PUF. At present, these modules are being optimized for practical applications. The experts will be at embedded world in Nuremberg (hall 11, stand 203) from March 1-3 to showcase FPGA boards that can generate an individual cryptographic key using a ring oscillator PUF. These allow attack-resistant security solutions to be rolled out in embedded systems.

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/2011/02/110208091719.htm

Conceptualizing Cancer Cells as Ancient 'Toolkit'



Two scientists, including ASU's Paul Davies, write about the idea that cancer has ancient evolutionary roots in a paper released Feb. 7 in the journal Physical Biology. Davies heads up the Center for the Convergence of Physical Sciences and Cancer Biology at ASU, a major research initiative funded by the National Cancer Institute. His center is investigating insights from physical science on cancer cells, similar to the ones in this image. Shown here, the upper row shows a normal breast cell with a smooth nuclear membrane of regular shape. The bottom row shows an aggressive breast cancer cell with a distinctively irregular nucleus and overall shape. The left column shows the whole cell, with the cytoplasm appearing as a gray haze. The middle column shows the naked nuclear membrane and the right column shows density variations in the nuclear DNA. (Credit: Image courtesy of Vivek Nandakumar, Center for Biosignatures Discovery Automation, Biodesign Institute, Arizona State University)

ScienceDaily (Feb. 8, 2011) — Despite decades of research and billions of dollars, cancer remains a major killer, with an uncanny ability to evade both the body's defenses and medical intervention. Now an Arizona State University scientist believes he has an explanation.

"Cancer is not a random bunch of selfish rogue cells behaving badly, but a highly-efficient pre-programmed response to stress, honed by a long period of evolution," claims professor Paul Davies, director of the BEYOND Center for Fundamental Concepts in Science at ASU and principal investigator of a major research program funded by the National Cancer Institute designed to bring insights from physical science to the problem of cancer.

In a paper published online Feb. 7 in the UK Institute of Physics journal *Physical Biology*, Davies and Charles Lineweaver from the Australian National University draw on their backgrounds in astrobiology to explain why cancer cells deploy so many clever tricks in such a coherent and organized way.

They say it's because cancer revisits tried-and-tested genetic pathways going back a billion years, to the time when loose collections of cells began cooperating in the lead-up to fully developed multicellular life. Dubbed by the authors "Metazoa 1.0," these early assemblages fell short of the full cell and organ differentiation associated with modern multicellular organisms -- like humans.

But according to Davies and Lineweaver, the genes for the early, looser assemblages -- Metazoa 1.0 -- are still there, forming an efficient toolkit. Normally it is kept locked, suppressed by the machinery of later genes used for more sophisticated body plans. If something springs the lock, the ancient genes systematically roll out the many traits that make cancer such a resilient form of life -- and such a formidable adversary.

"Tumors are a re-emergence of our inner Metazoan 1.0, a throwback to an ancient world when multicellular life was simpler," says Davies. "In that sense, cancer is an accident waiting to happen."

If Davies and Lineweaver are correct, then the genomes of the simplest multicellular organisms will hide clues to the way that cancer evades control by the body and develops resistance to chemotherapy. And their approach suggests that a limited number of genetic pathways are favored by cells as they become progressively genetically unstable and malignant, implying that cancer could be manageable by a finite suite of drugs in the coming era of personalized medicine.

"Our new model should give oncologists new hope because cancer is a limited and ultimately predictable atavistic adversary," says Lineweaver. "Cancer is not going anywhere evolutionarily; it just starts up in a new patient the way it started up in the previous one."
The authors also believe that the study of cancer can inform astrobiology. "It's not a one-way street," says Davies. "Cancer can give us important clues about the nature and history of life itself."

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

Journal Reference:

1. P. C. W. Davies, C. H. Lineweaver. **Cancer tumors as Metazoa 1.0: tapping genes of ancient ancestors**. *Physical Biology*, 2011; 8: 015001 DOI: 10.1088/1478-3975/8/1/015001

http://www.sciencedaily.com/releases/2011/02/110207133704.htm

Researchers Predict Future of Electronic Devices, See Top Ten List of Expected Breakthroughs

Within ten to 20 years, we will see e-Devices with magazine-quality color, viewable in bright sunlight but requiring low power. "Think of this as the green iPad or e-Reader, combining high function and high color with low power requirements." said Heikenfeld. (Credit: Noel Leon Gauthier, U. of Cincinnati)

ScienceDaily (Feb. 8, 2011) — In the first published critical review of technical developments related to electronic paper devices (i.e., e-readers like the Amazon Kindle), UC researcher Jason Heikenfeld and industry counterparts review the next generation of these devices.

The just-released February issue of the Journal of the Society for Information Display contains the first-ever critical review of current and future prospects for electronic paper functions -- in other words reviewing and critiquing the technologies that will bring us devices like

- full-color, high-speed, low-power e-readers;
- iPads that can be viewed in bright sunlight, or
- e-readers and iPads so flexible that they can be rolled up and put in a pocket.

The University of Cincinnati's Jason Heikenfeld, associate professor of electrical and computer engineering and an internationally recognized researcher in the field of electrofluidics, is the lead author on the paper titled "A Critical Review of the Present and Future Prospects for Electronic Paper." Others contributing to the article are industry researcher Paul Drzaic of Drzaic Consulting Services; research scientist Jong-Souk (John) Yeo of Hewlett-Packard's Imaging and Printing Group; and research scientist Tim Koch, who currently manages Hewlett-Packard's effort to develop flexible electronics.

Based on this latest article and his ongoing research and development related to e-paper devices, UC's Heikenfeld provides the following top ten list of electronic paper devices that consumers can expect both near term and in the next ten to 20 years.

Heikenfeld is part of a UC team that specializes in research and development of e-devices.

Coming later this year:

- **Color e-readers** will be out in the consumer market by mid year in 2011. However, cautions Heikenfeld, the color will be muted as compared to what consumers are accustomed to, say, on an iPad. Researchers will continue to work toward next-generation (brighter) color in e-Readers as well as high-speed functionality that will eventually allow for point-and-click web browsing and video on devices like the Kindle.

Already in use but expansive adoption and breakthoughs imminent:

- **Electronic shelf labels in grocery stores.** Currently, it takes an employee the whole day to label the shelves in a grocery store. Imagine the cost savings if all such labels could be updated within seconds -- allowing for, say, specials for one type of consumer who shops at 10 a.m. and updated specials for other shoppers stopping in at 5:30 p.m. Such electronic shelf labels are already in use in Europe and the West Coast and in limited, experimental use in other locales. The breakthrough for use of such electronic labels came when they could be implemented as low-power devices. Explained Heikenfeld, "The electronic labels basically only consume significant power when they are changed. When it's a set, static message and price, the e-shelf label is consuming such minimal power -- thanks to reflective display technology -- that it's highly economical and effective." The current e-shelf labels are monochrome, and researchers will keep busy to create high-color labels with low-power needs.

- **The new "no knobs" etch-a-sketch**. This development allows children to draw with electronic ink and erase the whole screen with the push of a button. It was created based on technology developed in Ohio (Kent State University). Stated Heikenfeld, "Ohio institutions, namely the University of Cincinnati and Kent State, are international leaders in display and liquid optics technology."

- **Technology in hot-selling Glow Boards will soon come to signage**. Crayola's Glow Board is partially based on UC technology developments, which Crayola then licensed. While the toy allows children to write on a surface that lights up, the technology has many applications, and consumers can expect to see those imminently. These include indoor and outdoor sign displays that when turned off, seem to be clear windows. (Current LCD -- liquid crystal display -- sign technology requires extremely high power usage, and when turned off, provide nothing more than a non-transparent black background.)

Coming within two years:

- **An e-device that will consume little power while also providing high function and color (video playing and web browsing) while also featuring good visibility in sunlight.** Cautions Heikenfeld, "The color on this first-generation low-power, high-function e-device won't be as bright as what you get today from LCD (liquid crystal display) devices (like the iPad) that consume a lot of power. The color on the new low-power, high-function e-device will be about one third as bright as the color you commonly see on printed materials. Researchers, like those of us at UC, will continue to work to produce the Holy Grail of an e-device: bright color, high function (video and web browsing) with low power usage."

Coming within three to five years:

- **Color adaptable e-device casings.** The color and/or designed pattern of the plastic casing that encloses your cell phone will be adaptable. In other words, you'll be able to change the color of the phone itself to a professional black-and-white for work or to a bright and vivid color pattern for a social outing. "This is highly achievable," said Heikenfeld, adding, "It will be able to change color either automatically by reading the color of your outfit that day or by means of a downloaded app.

It's possible because of low-power, reflective technology" (wherein the displayed pattern or color change is powered by available ambient light vs. powered by an electrical charge).

Expect the same feature to become available in devices like appliances. "Yes," said Heikenfeld, "We'll see a color-changing app, so that you can have significant portions of your appliances be one color one day and a different color or pattern the next."

- **Bright-color but low-power digital billboards visible both night and day**. Currently, the digital billboards commonly seen are based on LEDs (liquid crystal displays), which consume high levels of electric power and still lose color when in direct sunlight. Heikenfeld explained, "We have the technology that would allow these digital billboards to operate by simply reflecting ambient light, just like conventional printed billboards do. That means low power usage and good visibility for the displays even in bright sunlight. However, the color doesn't really sizzle yet, and many advertisers using billboards will not tolerate a washed-out color."

- **Foldable or roll-it-up e-devices**. Expect that the first-generation foldable e-devices will be monochrome. Color will come later. The first foldable e-devices will come from Polymer Vision in the Netherlands. Color is expected later, using licensed UC-developed technology. The challenge, according to Heikenfeld, in creating foldable e-devices has been the device screen, which is currently made of rigid glass. But what if the screen were a paper-thin plastic that rolled like a window shade? You'd have a device like an iPad that could be folded or rolled up tens of thousands of times. Just roll it up and stick it in your pocket.

Within ten to 20 years:

- **e-Devices with magazine-quality color, viewable in bright sunlight but requiring low power.** "Think of this as the green iPad or e-Reader, combining high function and high color with low power requirements." said Heikenfeld.

- **The e-Sheet, a virtually indestructible e-device that will be as thin and as rollable as a rubber place mat.** It will be full color and interactive, while requiring low power to operate since it will charge via sunlight and ambient room light. However, it will be so "tough" and only use wireless connection ports, such that you can leave it out over night in the rain. In fact, you'll be able to wash it or drop it without damaging the thin, highly flexible casing.

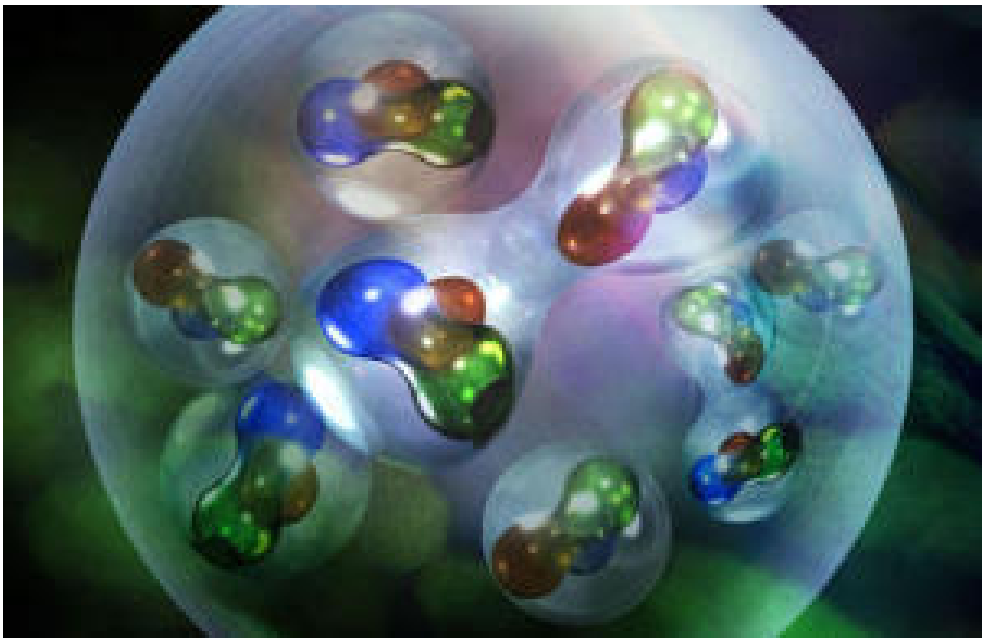
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of Cincinnati**. The original article was written by M.B. Reilly.

Journal Reference:

1. Jason Heikenfeld, Paul Drzaic, Jong-Souk Yeo, Tim Koch. **Review Paper: A critical review of the present and future prospects for electronic paper**. *Journal of the Society for Information Display*, 2011; 19 (2): 129 DOI: 10.1889/JSID19.2.129

http://www.sciencedaily.com/releases/2011/02/110208101324.htm

Bound Neutrons Pave Way to Free Ones: Scientists Extract Information About Internal Structure of Free Neutrons



Some experiments seem to show that the building blocks of protons and neutrons inside a nucleus are somehow different from that of free ones. Other experiments show they behave differently when they pair up: they move faster and frequently overlap. (Credit: Image courtesy of DOE/Thomas Jefferson National Accelerator Facility)

ScienceDaily (Feb. 7, 2011) — A study of *bound* protons and neutrons conducted at the Department of Energy's Thomas Jefferson National Accelerator Facility has allowed scientists, for the first time, to extract information through experimentation about the internal structure of *free* neutrons, without the assistance of a theoretical model.

The result was published in the Feb. 4 issue of *Physical Review Letters*.

The major hurdle for scientists who study the internal structure of the neutron is that most neutrons are bound up inside the nucleus of atoms to protons. In nature, a free neutron lasts for only a few minutes, while in the nucleus, neutrons are always encumbered by the ubiquitous proton.

To tease out a description of a free neutron, a group of scientists compared data collected at Jefferson Lab and the SLAC National Accelerator Laboratory that detail how bound protons and neutrons in the nucleus of the atom display two very different effects. Both protons and neutrons are referred to as nucleons.

"Both effects are due to the nucleons behaving like they are not free," says Doug Higinbotham, a Jefferson Lab staff scientist.

Nucleons appear to differ when they are tightly bound in heavier nuclei versus when they are loosely bound in light nuclei. In the first effect, experiments have shown that nucleons tightly bound in a heavy nucleus pair up more often than those loosely bound in a light nucleus.

"The first thing was the probability of finding two nucleons close together in the nucleus, what we call a short-range correlation," says Larry Weinstein, a professor at Old Dominion University. "And the probability that the two nucleons are in a short-range correlation increases as the nucleus gets heavier."

Meanwhile, other experiments have shown a clear difference in how the proton's building blocks, called quarks, are distributed in heavy nuclei versus light nuclei. This difference is called the EMC Effect.

"People were measuring and discussing the EMC Effect. And people were discussing things about the short-range correlations effect. Nobody bothered to look to see if there's any connection between them," adds Eliezer Piasetzky, a professor at Tel Aviv University in Israel.

When the group combined the data from a half-dozen experiments regarding these two different effects on one graph, they found that the two effects were correlated.
"Take a quantity that tells you how strong the EMC Effect is. And then take another quantity that tells you how many short-range correlations you have," Higinbotham explains. "And you see that when one is big, the other one is big. When one is small, the other one is small."
The scientists say that it's unlikely that one effect causes the other. Rather, the data shows that there is a common cause for both.
"I think that we certainly agree that from the position picture, it's due to nucleons overlapping that is causing this. And in the momentum picture, it is the high-momentum nucleons that are causing this. And, of course, it's quantum mechanics, so choose your picture," Higinbotham explains.
The group says the common cause may have remained a mystery for so long, because while the two effects they are studying are obviously related when laid out on a graph, the connection was previously obscured by the different, yet related ways in which the two effects are studied.
"When you do a measurement for the EMC Effect, what you do is you look inside the nucleon. You break open the nucleon and see inside. What happens inside the nucleon is very different from the short-range correlations, which is what happens between two different nucleons," Piasetzky says.
"What's very new here is that we have linked two fields that were completely disconnected. So now you can start asking questions about what that connection can help us learn," Higinbotham says.
They say the next step is to further compare the data from all of the source experiments that they used in their analysis to see if data for one effect may now be used to learn something new about the other. Then, of course, they'd like to use the knowledge that the two effects are connected to design new experiments for shining a light on other secrets buried in the nucleus of the atom.
This work was supported in part by the DOE Office of Science, the National Science Foundation, the Israel Science Foundation, and the U.S.-Israeli Bi-National Science Foundation.

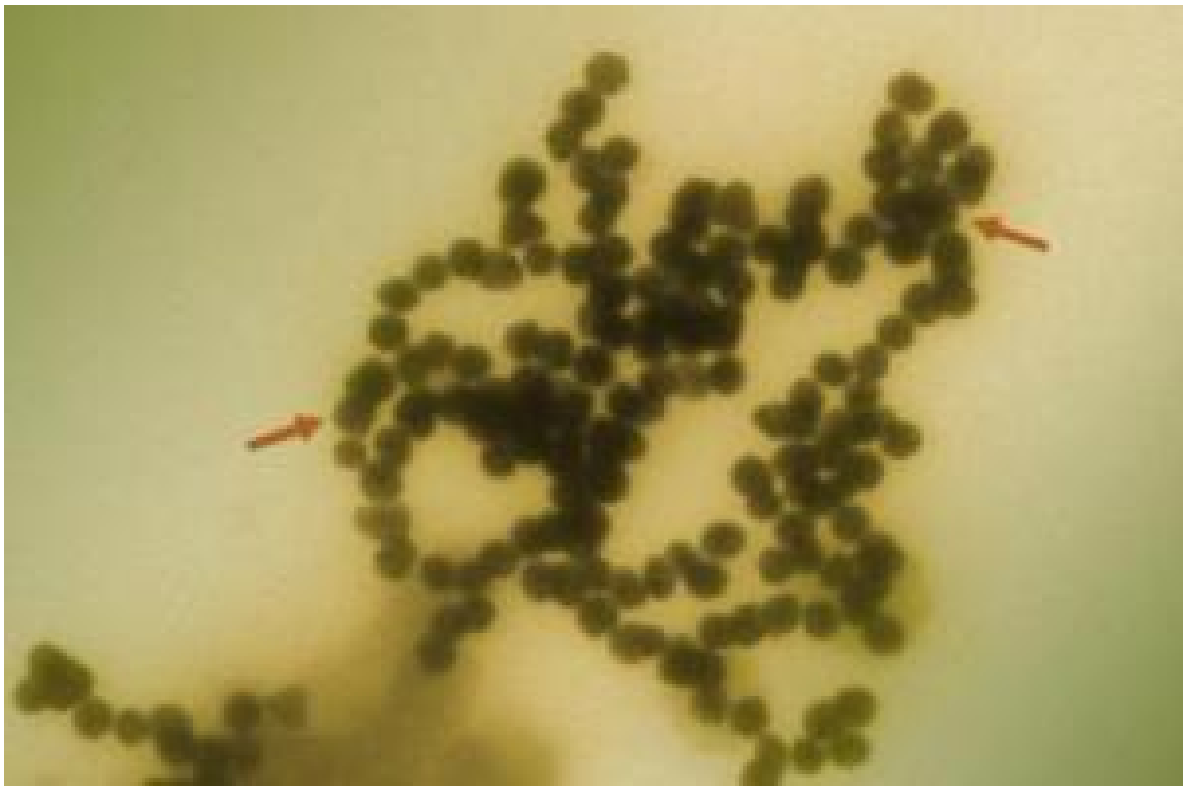
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **DOE/Thomas Jefferson National Accelerator Facility**.

Journal Reference:

1. L. Weinstein, E. Piasetzky, D. Higinbotham, J. Gomez, O. Hen, R. Shneor. **Short Range Correlations and the EMC Effect**. *Physical Review Letters*, 2011; 106 (5) DOI: 10.1103/PhysRevLett.106.052301

http://www.sciencedaily.com/releases/2011/02/110207172647.htm

New Technique Controls Sizes of Nanoparticle Clusters for Environmental, Health and Safety Studies



Transmission electron micrograph of gold nanoparticles clustering in solution. The distance between the two red arrows is approximately 280 nanometers, some 200 times smaller than the diameter of a human hair. The individual nanoparticles are approximately 15 nanometers in diameter, about the distance across three side-by-side sodium atoms. (Credit: A. Keene, US Food and Drug Administration)

ScienceDaily (Feb. 8, 2011) — The same properties that make engineered nanoparticles attractive for numerous applications -- small as a virus, biologically and environmentally stabile, and water-soluble -- also cause concern about their long-term impacts on environmental health and safety (EHS). One particular characteristic, the tendency for nanoparticles to clump together in solution, is of great interest because the size of these clusters may be key to whether or not they are toxic to human cells. Researchers at the National Institute of Standards and Technology (NIST) have demonstrated for the first time a method for producing nanoparticle clusters in a variety of controlled sizes that are stable over time so that their effects on cells can be studied properly.

In their tests, the NIST team made samples of gold, silver, cerium oxide and positively-charged polystyrene nanoparticles and suspended them separately in cell culture medium, allowing clumping to occur in each. They stopped the clumping by adding a protein, bovine serum albumin (BSA), to the mixtures. The longer the nanoparticles were allowed to clump together, the larger the size of the resulting cluster. For example, a range of clustering times using 23 nanometer silver nanoparticles produced a distribution of masses between 43 and 1,400 nanometers in diameter. Similar size distributions for the other three nanoparticle types were produced using this method.

The researchers learned that using the same "freezing times" -- the points at which BSA was added to halt the process -- yielded consistent size distributions for all four nanoparticle types. Additionally, all of the BSA-controlled dispersions remained stable for 2-3 days, which is sufficient for many toxicity studies.

Having successfully shown that they could control the production of nanoparticle clumps of different sizes, the researchers wanted next to prove that their creations could be put to work. Different-sized silver nanoparticle clusters were mixed with horse blood in an attempt to study the impact of clumping size on red blood cell toxicity. The presence of hemoglobin, the iron-based molecule in red blood cells that carries

oxygen, would tell researchers if the cells had been lysed (broken open) by silver ions released into the solution from the clusters. In turn, measuring the amount of hemoglobin in solution for each cluster size would define the level of toxicity -- possibly related to the level of silver ion release -- for that specific average size.

What the researchers found was that red blood cell destruction decreased as cluster size increased. They hypothesize that large nanoparticle clusters dissolve more slowly than small ones, and therefore, release fewer silver ions into solution.

In the future, the NIST team plans to further characterize the different cluster sizes achievable through their production method, and then use those clusters to study the impact on cytotoxicity of coatings (such as polymers) applied to the nanoparticles.

Story Source:

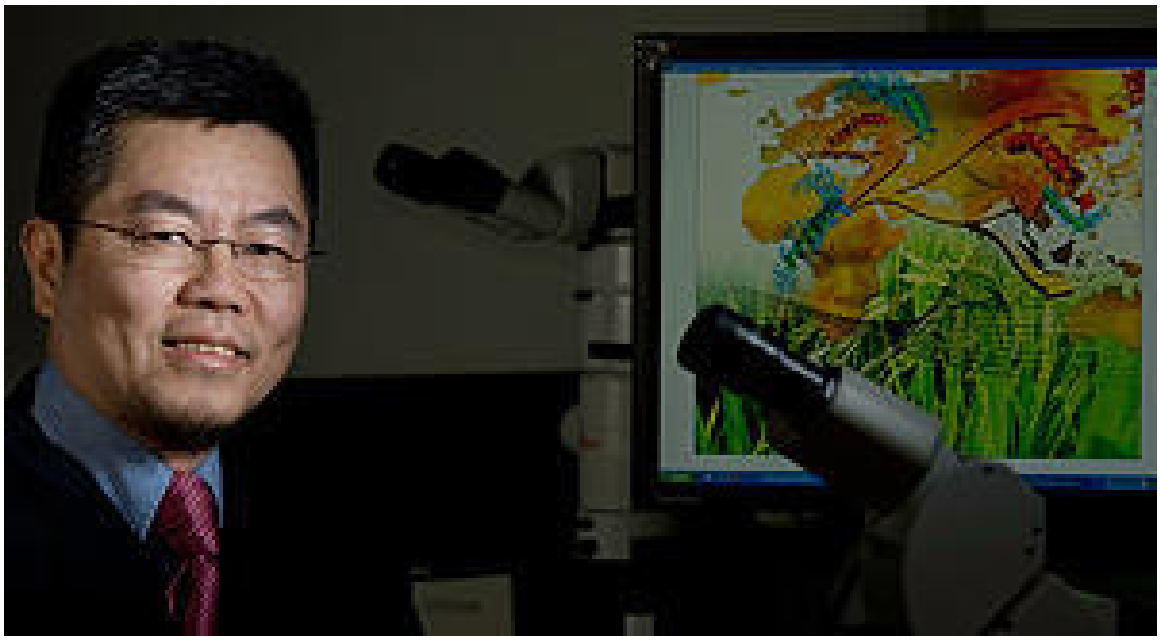
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **National Institute of Standards and Technology (NIST)**.

Journal Reference:

1. Justin M. Zook, Robert I. MacCuspie, Laurie E. Locascio, Melissa D. Halter, John T. Elliott. **Stable nanoparticle aggregates/agglomerates of different sizes and the effect of their size on hemolytic cytotoxicity**. *Nanotoxicology*, 2010; : 1 DOI: 10.3109/17435390.2010.536615

http://www.sciencedaily.com/releases/2011/02/110202132613.htm

Evolution Led to Genetic Variation That May Affect Diabetes, Scientist Says



Sheau Yu "Teddy" Hsu and his colleagues have found genetic variations in a hormone that are linked to the way blood-sugar levels are regulated in humans. (Credit: Steve Fisch)

ScienceDaily (Feb. 8, 2011) — The root causes of complex diseases such as type-2 diabetes and obesity have been difficult to identify because the diseases are, well, complex. They occur at the dicey biological intersection of genes and environment, and, because they arose in our relatively recent past, it's not easy to simply compare DNA sequences from "then" and "now" to pinpoint likely genetic culprits.

Now researchers at the Stanford University School of Medicine have identified genetic variations in a hormone involved in the secretion of insulin -- a molecule that regulates blood sugar levels -- that occur more frequently in some human populations than others. People with the "new" variants, which are thought to have first occurred 2,000 to 12,000 years ago, have higher fasting levels of blood glucose than those with the more traditional, or ancestral, form of the gene. High blood glucose levels are associated with the development of diabetes, which occurs when the body is unable to produce or respond properly to insulin.

The finding may help scientists better understand the subtle changes in human metabolism, or "energy balance regulation," that occurred as our species shifted from being primarily hunter-gatherers to a more agriculturally based society. It may also help clinicians identify individuals likely to develop diabetes, and direct the development of new therapies for diabetes and obesity.

"These studies are fascinating because it shows how much the selection process has affected human energy-balance regulation in just a few thousand years and how complex it could be for the future practice of personalized medicine," said Sheau Yu "Teddy" Hsu, PhD, assistant professor of obstetrics and gynecology and senior author of the study.

The research will be published online Feb. 7 in *Diabetes*. It follows a similar paper in the January issue of *Genome Research* that also explored the recent evolution of energy balance regulation, or how humans choose whether and how to store excess calories, among populations.

In the new paper, Hsu and his colleagues at Chang Gung Memorial Hospital in Taiwan and Texas A&M University first identified 207 genetic regions that have been associated with diabetes or obesity. They then looked to see which of these had increased in prevalence in the time since humans began to move out of Africa about 60,000 years ago. They identified 59 genetic regions of particular interest, and homed in on those that occurred in at least 30 percent of people in the HapMap project -- a worldwide survey of genetic differences among populations. (Restricting their search to relatively common variants ensured that their findings would be widely applicable and would provide a more powerful tool to identify any associated phenotype differences.)

The researchers identified five genes with genetic differences that occurred frequently in Asians and/or Europeans, but infrequently in Africans. (These groups were pre-identified as part of the HapMap project, which sampled people of Nigerian, Chinese, Japanese and European ancestry.) Hsu's team selected GIP, one of the five genes, for further study because the GIP protein was known to be involved in stimulating insulin secretion in humans after a meal.

"We thought GIP was the most interesting because the newly selected form occurs in about 50 percent of people from Europe or Asia, but in only about 5 percent of Africans. That indicates this gene is highly adaptable to new environments," said Hsu.

He and his colleagues identified three individual changes in the regulatory region of GIP -- that is, the DNA adjacent to the GIP gene that affects when and how it is translated into protein -- that reduced the levels of the hormone. What's more, these three also tended to occur with another mutation in the coding region that results in a slightly different form of the protein. This alternate form is degraded more slowly in human blood.

"So now we know there are two different forms of the protein, which allowed one form to be selected in one population, and the other in a different population," said Hsu. "But we still needed to show that these variants led to phenotypic differences in modern humans."

Because previous studies of GIP variants hadn't showed any conclusive differences among their human carriers, Hsu and his colleagues focused their study more narrowly on a population that is not only metabolically challenged, but also critical to evolutionary success: pregnant women. They found that, out of 123 East Asian pregnant women, those who carried two copies of the newly evolved variant had significantly lower levels of GIP circulating in their blood. These women were also at a significantly increased risk to have fasting blood glucose levels that exceeded the recommended threshold of 140 mg/dL (48.3 percent vs. 20.9 percent of those who carry the ancestral variant).

The finding is particularly interesting because it may help clinicians identify pregnant women likely to develop gestational diabetes, according to Hsu. But it also gives a glimpse into our not-so-distant past and the ways our ancestors grappled with environmental change.

"Like other humans at the time, the Eurasian population really had to fight for survival," said Hsu. "Now we're starting to pinpoint how they did that on a molecular level. These gene variants, and the resulting higher blood sugar levels it fostered, may have helped women maintain successful pregnancies in the face of the inevitable famines that occur in an agriculturally based society. Now, in a more food-secure environment, variations in GIP could contribute to the development of diabetes or obesity."

In addition to Hsu, James Cai, PhD, a former Stanford postdoctoral scholar in biology, was also involved in the study. He is now an assistant professor at Texas A&M University.

The research was funded by the National Institutes of Health, the Avon Foundation and Chang Gung Memorial Hospital.

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Stanford University Medical Center**. The original article was written by Krista Conger.

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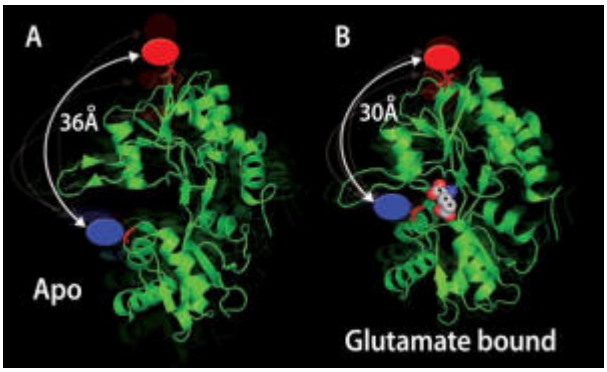
http://www.sciencedaily.com/releases/2011/02/110207165424.htm

Digital Signal Processing Helps Researchers Get a Grip on Nervous System's Receptors



Crystal structures of the GluA2 receptor show the C-clamp-like binding sites and the positions of fluorescent labels (the blue and red ovals) used to measure the sites in the apo (or agonist-free) and glutamate-bound forms. (Credit: Rice University/University of Texas Health Science Center)

ScienceDaily (Feb. 8, 2011) — A digital signal processing technique long used by statisticians to analyze data is helping Houston scientists understand the roots of memory and learning, Alzheimer's and Parkinson's diseases and stroke.

Researchers at Rice University and the University of Texas Health Science Center at Houston (UTHealth) reported in the journal *Nature Chemical Biology* that single molecule fluorescence resonance energy transfer (FRET) techniques combined with wavelet transforms have given them a new view of the AMPA receptor, a glutamate receptor and a primary mediator of fast signal transmission in the central nervous system.

Scientists have long thought these receptor proteins, which bind to glutamate to activate the flow of ions through the nervous system, are more than simple "on-off" switches. A "cleft" in the AMPA protein that looks and acts like a C-clamp and that binds the neurotransmitter glutamate may, in reality, serve functions at positions between fully open (off) and fully closed (on).

"In the old days, the binding was thought to be like a Venus flytrap," said Christy Landes, a Norman Hackerman-Welch Young Investigator Assistant Professor of Chemistry at Rice and lead author of the new paper. "The trap sat there waiting for something to come into the cleft. A neurotransmitter would come in and -- oops! -- it snapped shut on the molecule it was binding to, the gate opened up and ions would flow. We have all sorts of high-quality X-ray crystallography studies to show us what the snapped-open and snapped-shut cleft looks like."

But X-ray images likely show the protein in its most stable -- not necessarily its most active -- conformation, she said. Spectroscopy also has its limits: If half the proteins in an assay are open and half are shut, the measured average is 50 percent, a useless representation of what's really going on.

The truth, Landes said, is that the clefts of AMPA receptors are constantly opening and closing, exploring their space for neurotransmitters. "We know these proteins are super dynamic whether glutamate is present or not," she said. "And we need to look at one protein at a time to avoid averaging."

But seeing single protein molecules go through the motions is well beyond the capability of standard optical tools. That led the researchers to employ a unique combination of technologies. Vasanthi Jayaraman, an associate professor in UTHealth's Department of Biochemistry and Molecular Biology who studies chemical signaling, started the process when she used the binding domain of the AMPA receptor and attached fluorescent dyes to the points of the cleft in a way that would not affect their natural function.

Single-molecule FRET allowed Landes and her team to detect the photons emitted by the dyes. "These experiments had to be done in a box inside a box inside a box in a dark room," she said. "In a short period of measurement, we might be counting 10 photons."

The trick, she said, was to excite only one dye, which would in turn activate the other. "The amount of light that comes out of the dyes has a direct relationship to the distance between the dyes," Landes said. "You excite one, you measure both, and the relative amount of light that comes out of the one you're not exciting depends on how close they are."

Detecting very small changes in the distance between the two points over a period of time required calculations involving wavelets, a tool Rice mathematicians helped develop in the '70s and '80s. (Another recent paper by Landes and Taylor on their wavelet optimization method appears here.)

Wavelets allowed the researchers to increase the resolution of FRET results by reducing shot noise -- distortion at a particular frequency -- from the data. It also allowed them to limit measurements to a distinct time span -- say, 100 milliseconds -- during which the AMPA receptor would explore a range of conformations. They identified four distinct conformations in an AMPA receptor bound to a GluA2 agonist (which triggers the receptor response). Other experiments that involved agonist-free AMPA or AMPA bound to mutated glutamate showed an even floppier receptor.

Knowing how cleft positions match up with the function is valuable, said Jayaraman, who hopes to extend the technique to other signaling proteins with the ultimate goal of designing drugs to manipulate proteins implicated in neurological diseases.

"It was a beautiful combination," she said of the experiments. "We had done a lot of work on this protein and figured out the basic things. What was lacking was this one critical aspect. Being able to collaborate with a physical chemist (Landes) who had the tools allowed us to get details about this protein we wouldn't have seen otherwise."

"Physical chemistry, for all of its existence, amounts to coming up with new tricks to be able to calculate things that nature would not have us calculate," Landes said. "I think our true contribution is to be able to analyze this noisy data to get to what's underneath."

Co-authors of the paper are Anu Rambhadran, a graduate student at UTHealth, and Rice graduate students J. Nick Taylor and Ferandre Salatan.

The American Chemical Society Petroleum Research Fund, the National Institutes of Health and the American Heart Association supported the research.

Story Source:

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

Journal Reference:

1. Christy F Landes, Anu Rambhadran, J Nick Taylor, Ferandre Salatan, Vasanthi Jayaraman. **Structural landscape of isolated agonist-binding domains from single AMPA receptors**. *Nature Chemical Biology*, 2011; DOI: 10.1038/nchembio.523

http://www.sciencedaily.com/releases/2011/02/110207131846.htm

Air-Conditioned Greenhouse Uses Alternative Energy

Air-conditioned greenhouse uses alternative energy. (Credit: Image courtesy of Basque Research)

ScienceDaily (Feb. 8, 2011) — Neiker-Tecnalia (The Basque Institute for Agricultural Research and Development) has created an air-conditioned greenhouse using alternative energies that enable the reduction of energy costs, improvements in energy efficiency and an increase in crop yields. The novel system has a biomass boiler and thermodynamic solar panels, which reach an optimum temperature for the crop without using fuels derived from petroleum oil or gas.

Neiker-Tecnalia has installed a biomass boiler (using wood and other organic waste as fuel), together with thermodynamic panels, with the goal of air-conditioning greenhouses destined for intensive crop cultivation. With this method they have managed to reduce costs and improve crop yields, in such a way that seasonal products can be harvested throughout the year. This project seeks an alternative to the usual diesel or heating oil boilers, which emit significant amounts of CO_2 to the atmosphere and are very costly for the farmer, given the high price of petroleum oil-derived fuels.

400 kW power

The project was undertaken at a greenhouse in NEIKER-Tecnalia located in Derio, in the Basque province of Bizkaia and near Bilbao. A biomass boiler which produces 400 kW power and is, to date, the largest in Spain using air-conditioning in greenhouses was installed. With the boiler there are 40 thermodynamic panels, employed for the first time in intensive greenhouse cultivation. The combination of both energies act to heat the water which circulates in tubes located a few centimetres above the floor and below the substrate of the crop, the aim being to heat the roots.

The tubes, distributed throughout the whole surface of the greenhouse, transport water at an average temperature of 80 degrees centigrade. Thus optimum air-conditioning for greenhouses is achieved, with the result that the plants grow as in the natural production period. Achieving less expenditure in consumption and having seasonal crops all year round considerably reduces the price of the final product and, thus, enabling competition in the market with products coming from other zones.

The thermodynamic panels used generate energy thanks to the difference in temperature between a cold gas that circulates through a closed circuit and the ambient air temperature. They outstand for their low energy cost, as they are able to function in situations without sunlight and, thereby, produce energy both by day and

by night. Moreover, it drastically reduces emissions of CO_2 to the atmosphere. They are capable of heating water to 45 degrees centigrade and their cost per kilowatt consumed is 60 % less than the one generated by conventional diesel or heating oil boilers.
The biomass boiler used by Neiker-Tecnalia works with organic waste, such as almond nut shells, olive oil stones, tree pruning cuttings, the waste obtained from clearing forests, granulated pellets of sawdust, sawdust itself, wood shavings or any other leftover from the timber industry. The expenditure in fuel for the biomass boiler is 55 cents for kilowatt consumed, well below the 92 cents of a euro needed for boilers fed by petroleum oil-derived fuels or by natural gas or propane.

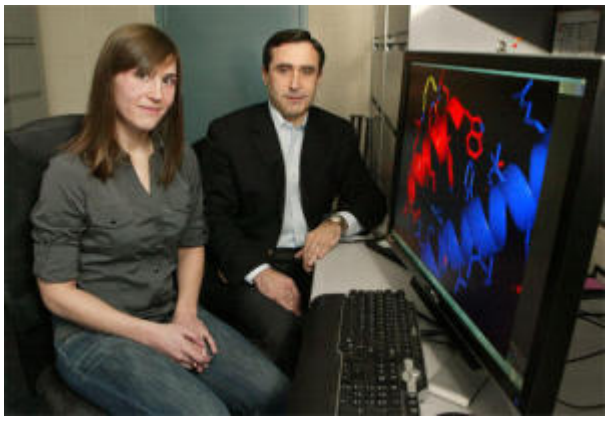
Heating the roots to reduce costs

Air-conditioning using alternative energies developed by Neiker-Tecnalia is complemented with a technique known as 'hydroponic soil', involving placing the plants on substrate at a height of some ten centimetres above the hard floor of the greenhouse. This method also enables the roots to be heated by pipes through which water circulates at an average temperature of 45 degrees centigrade. Directly heating the substrate where the roots are found enables reducing the ambient temperature of the greenhouse overall, thus involving less energy expenditure.
This system involves a network of sensors (distributed throughout the greenhouse) that enables regulating the temperature of the market garden. The meters gather data in real time on the temperature and humidity of the crop zone. The data is sent to a computer which has software capable of programming different actions, such as increasing or reducing the temperature of the greenhouse or fixing the most appropriate hours for heating the plants.

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

http://www.sciencedaily.com/releases/2011/02/110202132619.htm

Math May Help Calculate Way to Find New Drugs for HIV and Other Diseases



Princeton researchers, Christodoulos Floudas and Meghan Bellows-Peterson, have developed a way to use mathematical models to take some of the guesswork out of discovering new drugs. Using the technique, they have identified several potential new drugs for fighting HIV. The image on the screen shows a graphic of their drug candidate (red) attached to HIV (blue). (Credit: Photo by Frank Wojciechowski)

ScienceDaily (Feb. 8, 2011) — Using mathematical concepts, Princeton researchers have developed a method of discovering new drugs for a range of diseases by calculating which physical properties of biological molecules may predict their effectiveness as medicines.

The technique already has identified several potential new drugs that were shown to be effective for fighting strains of HIV by researchers at Johns Hopkins University.

"The power of this is that it's a general method," said Princeton chemical and biological engineering professor Christodoulos Floudas, who led the research team. "It has proven successful in finding potential peptides to fight HIV, but it should also be effective in searching for drugs for other diseases."

Floudas, the Stephen C. Macaleer '63 Professor in Engineering and Applied Science, and Princeton engineering doctoral student Meghan Bellows-Peterson collaborated on the study with researchers at the Johns Hopkins University School of Medicine. Their findings were reported in the Nov. 17, 2010, issue of *Biophysical Journal*.

The researchers' technique combines concepts from optimization theory, a field of mathematics that focuses on calculating the best option among a number of choices, with those of computational biology, which combines mathematics, statistics and computer science for biology research.

In the case of HIV, the challenge for the Princeton team was to find peptides -- the small chains of biologically active amino acids that are the basic building blocks of proteins -- that could stop the virus from infecting human cells.

"The Princeton researchers have a very sophisticated way of selecting peptides that will fit a particular binding site on an HIV virus," said collaborator Robert Siliciano, a professor of medicine at Johns Hopkins and a 1974 Princeton graduate, who specializes in the treatment of HIV. "It narrows the possibilities, and may reduce the amount of time and resources it takes to find new drugs."

Fuzeon (enfuvirtide), is a peptidic drug commonly given to HIV patients for whom first-line HIV medications have not proven fully effective. Fuzeon costs nearly $20,000 per year, and patients must take it regularly due to its short period of effectiveness in the body. The researchers hoped to find an alternative to Fuzeon by discovering new peptides that would be cheaper to produce and allow patients to take fewer and smaller doses.

Fuzeon is thought to inhibit HIV by attaching to the virus and disabling a structure used to penetrate the protective membrane of human cells.

"The actual mechanism for entering cells is still uncertain, but there is a lot of evidence that points to this certain structure on the virus," Bellows-Peterson said. "We used the available data on the proteins that form the structure to help us predict what kind of drug might be effective against the virus."

The researchers reasoned that a shorter peptide -- Fuzeon is 36 amino acids long-- would be cheaper to produce and would last longer in the body, since shorter molecules are less susceptible to breakdown. Such formulations also might allow for drugs that could be taken as a pill instead of an injection.
The researchers' biological sleuthing focused on the physical relationship between peptides and the HIV protein structure that Fuzeon targets. The team developed a formula based on statistical thermodynamics to predict whether a given peptide, based on its sequence of amino acids, was likely to bind with the protein that HIV uses for penetrating cells.
This tendency to bind stems from the peptide's free energy state, a physical property related to its shape, which would change if it attached to the HIV protein. The researchers looked for peptides that would shift to a lower energy state after binding to the HIV protein, because these would be more likely to bind to the protein and thus be capable of blocking the virus from entering a cell.
Out of millions of possible peptides, the Princeton researchers used their formula to narrow their search to five promising drug candidates, each 12 amino acids long, one-third the length of Fuzeon. Their collaborators at Johns Hopkins then tested whether the peptides were truly effective at preventing HIV from entering human cells.
The Johns Hopkins scientists found that four of the five designed peptides inhibited HIV and that one of the peptides was particularly potent, even against strains of HIV that are resistant to treatment with Fuzeon. They also found that peptides designed by the Princeton researchers were nontoxic to cells.
"One could never test all the possible peptides to see if they are effective against HIV," Floudas said. "But this model was able to sort through millions of possibilities and identify just a few that show promise."
Now that they have identified possible candidates, the researchers plan to experiment with modifying the shape of the peptides to see if they can be made even more effective against the virus. They also hope to expand the use of the model to other diseases, particularly cancers.
"It's an approach to finding peptide-based drugs that target certain proteins, whether those of a virus or those of a cancerous cell," Floudas said.
In addition to Siliciano, collaborators from Johns Hopkins included Lin Shen, a former doctoral student; Philip Cole, a professor of pharmacology; and Martin Taylor, an M.D./Ph.D. candidate who graduated from Princeton in 2005. Hoki Fung, a former Princeton doctoral student who is currently serving as a postdoctoral fellow at École polytechnique fédérale de Lausanne in Switzerland, also participated in the research.
The research was supported by the National Science Foundation.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Princeton University, Engineering School**. The original article was written by Chris Emery.

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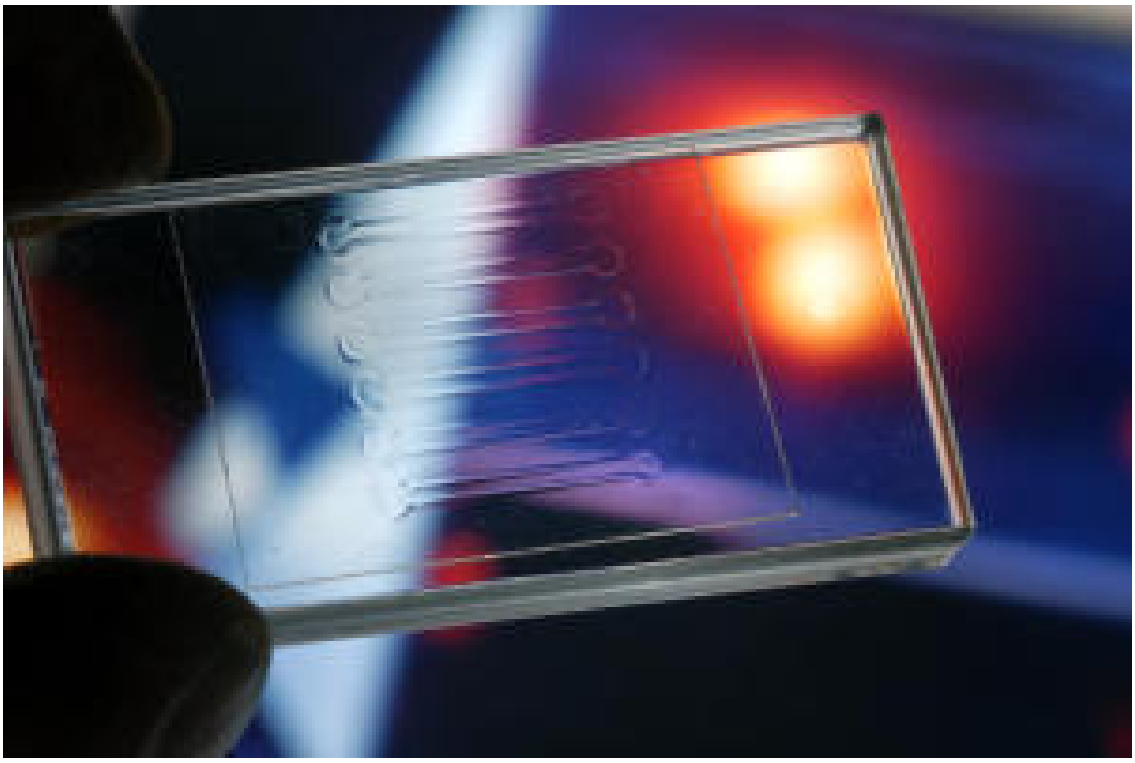
http://www.sciencedaily.com/releases/2011/02/110207103609.htm

Laser Welding in the Right Light



Transparent plastics can be joined via laser beam at a wavelength of around 1700 nanometers. (Credit: Copyright Fraunhofer ILT)

ScienceDaily (Feb. 8, 2011) — Laser welding is on the advance, but it also has its limits: it has been impossible to fuse two transparent plastic components together -- up until now. Researchers have now succeeded in circumventing this hurdle -- by choosing the right wavelength. The new welding process is revolutionizing bioanalytics.

It's a quick process, generates almost no waste and is extremely precise: within a few seconds, a laser beam has welded the casing and speedometer cover together -- without any screws, clamps or glues whatsoever. The result is a perfect weld seam scarcely visible to the naked eye. There are no sparks or particles flying through the air during welding. What's more: the resulting heat is confined to a minimal area. This protects the material. Many industries have now turned to welding plastics with a laser.

Still, the technology has its limits; when it comes to fusing two plastic components together, for instance, there is little freedom of choice. Up until now, the upper joining part had to be transparent to permit the laser to shine through unimpeded while the lower joining part absorbed the radiation. This usually meant soot particles had to be blended into the plastic. These particles absorb the energy of the laser beam and transmit the fusion heat generated to the upper joining part. "Up until now, you usually had to choose a single plastic combination: transparent and black. There are lots of applications -- in medical technology, for instance -- where what's needed is a combination of two transparent plastics," explains Dr.-Ing. Alexander Olowinsky, project manager at the Fraunhofer Institute for Laser Technology ILT in Aachen, Germany. The researcher and his team have now managed to erase the previous boundaries of laser welding.

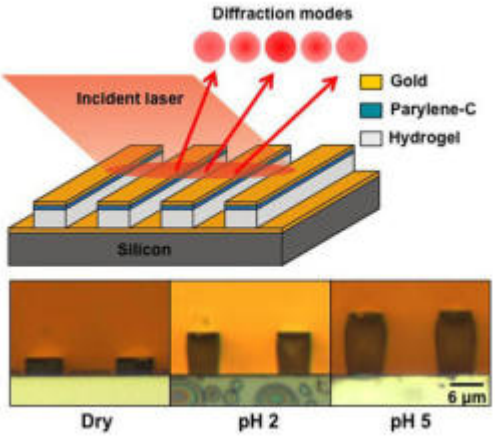
"The industry now also makes infrared absorbers that are nearly transparent, but these are not only very expensive but also have a green, yellowish tint to them," Olowinsky elaborates. "So our goal was to find a way to get the job done completely free of absorber materials." To accomplish this, researchers studied the absorption spectra of a range of transparent polymers in search of wavelength ranges within which plastic absorbs laser radiation. Then the scientists tested and perfected the laser systems to match: systems that emit light of the right wavelengths. '

"Before, you didn't have the right light source," Olowinsky adds. "It was only during the past few years that laser sources have been developed that emit light in these wavelength ranges." To deliver the light energy to the joining level -- to the seam along the border between the two transparent plastics -- the experts at ILT came up with special lens systems. These systems focus the beam so that the highest energy density occurs at the beam waist -- where the beam diameter is the smallest -- so that the highest temperature is delivered precisely to the joining level.
The researchers' most promising results were achieved at a wavelength of around 1700 nanometers. "This is the peak welding-efficiency range," Olowinsky summarizes. Nevertheless, the researchers are also continuing work on the EU Commission-sponsored "PolyBright" project in search of the combination of the right absorption bands with the matching light sources. "The result has to be the most cost-effective laser system possible that can execute high-precision welding tasks at the highest possible speed."
Medical technology and bioanalytics in particular are among the main beneficiaries of the new welding process: The magic word is "lab on a chip." This refers to automatic, miniature-sized laboratory analysis on the surface of a chip. Whether fluids, protein or DNA analyses -- the spectrum of applications is a broad one.

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/2011/02/110202114726.htm

Hydrogels Used to Make Precise New Sensor



This diagram depicts a new type of "diffraction-based" sensor made of thin stripes of a gelatinous material called a hydrogel, which expands and contracts depending on the acidity of its environment. The new type of biological and chemical sensor has few moving parts and works by precisely determining pH, revealing the identity of substances in liquid environments such as water or blood. The microscopic images at bottom show how the hydrogel stripes expand with decreasing acidity. (Credit: Birck Nanotechnology Center, Purdue University)

ScienceDaily (Feb. 8, 2011) — Researchers are developing a new type of biological and chemical sensor that has few moving parts, is low-cost and yet highly sensitive, sturdy and long-lasting.

The "diffraction-based" sensors are made of thin stripes of a gelatinous material called a hydrogel, which expands and contracts depending on the acidity of its environment.

Recent research findings have demonstrated that the sensor can be used to precisely determine pH -- a measure of how acidic or basic a liquid is -- revealing information about substances in liquid environments, said Cagri Savran (pronounced Chary Savran), an associate professor of mechanical engineering at Purdue University.

The sensor's simple design could make it more practical than other sensors in development, he said.

"Many sensors being developed today are brilliantly designed but are too expensive to produce, require highly skilled operators and are not robust enough to be practical," said Savran, whose work is based at Purdue's Birck Nanotechnology Center in the university's Discovery Park.

New findings show the technology is highly sensitive and might be used in chemical and biological applications including environmental monitoring in waterways and glucose monitoring in blood.

"As with any novel platform, more development is needed, but the detection principle behind this technology is so simple that it wouldn't be difficult to commercialize," said Savran, who is collaborating with another team of researchers led by Babak Ziaie, a Purdue professor of electrical and computer engineering and biomedical engineering.

Findings are detailed in a paper presented during the IEEE Sensors 2010 Conference in November and also published in the conference proceedings. The paper was written by postdoctoral researcher Chun-Li Chang, doctoral student Zhenwen Ding, Ziaie and Savran.

The flexible, water-insoluble hydrogel is formed into a series of raised stripes called a "diffraction grating," which is coated with gold on both the stripe surfaces and the spaces in between. The stripes expand and contract depending on the pH level of the environment.

Researchers in Ziaie's lab fabricated the hydrogel, while Savran's group led work in the design, development and testing of the diffraction-based sensor.

The sensors work by analyzing laser light reflecting off the gold coatings. Reflections from the stripes and spaces in between interfere with each other, creating a "diffraction pattern" that differs depending on the height of the stripes.

These diffraction patterns indicate minute changes in the movement of the hydrogel stripes in response to the environment, in effect measuring changes in pH.
"By precise measurement of pH, the diffraction patterns can reveal a lot of information about the sample environment," said Savran, who by courtesy is an associate professor of biomedical engineering and electrical and computer engineering. "This technology detects very small changes in the swelling of the diffraction grating, which makes them very sensitive."
The pH of a liquid is recorded on a scale from 0 to 14, with 0 being the most acidic and 14 the most basic. Findings showed the device's high sensitivity enables it to resolve changes smaller than one-1,000th on the pH scale, measuring swelling of only a few nanometers. A nanometer is about 50,000 times smaller than the finest sand grain.
"We know we can make them even more sensitive," Savran said. "By using different hydrogels, gratings responsive to stimuli other than pH can also be fabricated."
The work is ongoing.
"It's a good example of collaborations that can blossom when labs focusing on different research are located next to each other," Savran said. "Professor Ziaie's lab was already working with hydrogels, and my group was working on diffraction-based sensors. Hearing about the hydrogels work next door, one of my postdoctoral researchers, Chun-Li Chang thought of making a reflective diffraction grating out of hydrogels."
The Office of Technology Commercialization of the Purdue Research Foundation has filed for U.S. patent protection on the concept.

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

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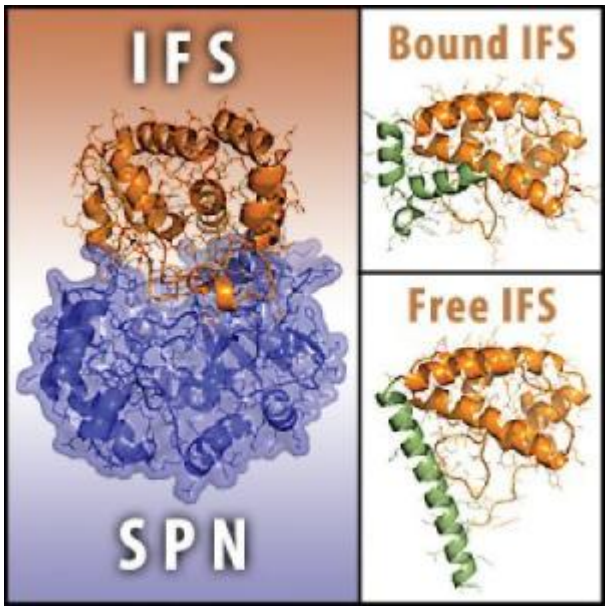
Turning Bacteria Against Themselves



The Streptococcus pyogenes toxin SPN (shown in purple) is inhibited by the antitoxin IFS (left, shown in orange). IFS blocks the active site of SPN and prevents NAD+ from binding. When bound to SPN, one end of IFS is folded into a compact form (upper right, shown in green). Alone, the same end of IFS extends straight out (lower right, shown in green). Forcing IFS to stay in this free state would release the SPN toxin to attack the bacteria themselves. (Credit: Image provided by Craig L. Smith)

ScienceDaily (Feb. 8, 2011) — Bacteria often attack with toxins designed to hijack or even kill host cells. To avoid self-destruction, bacteria have ways of protecting themselves from their own toxins.

Now, researchers at Washington University School of Medicine in St. Louis have described one of these protective mechanisms, potentially paving the way for new classes of antibiotics that cause the bacteria's toxins to turn on themselves.

Scientists determined the structures of a toxin and its antitoxin in *Streptococcus pyogenes*, common bacteria that cause infections ranging from strep throat to life-threatening conditions like rheumatic fever. In Strep, the antitoxin is bound to the toxin in a way that keeps the toxin inactive.

"Strep has to express this antidote, so to speak," says Craig L. Smith, PhD, a postdoctoral researcher and first author on the paper that appears Feb. 9 in the journal *Structure*. "If there were no antitoxin, the bacteria would kill itself."

With that in mind, Smith and colleagues may have found a way to make the antitoxin inactive. They discovered that when the antitoxin is not bound, it changes shape.

"That's the Achilles' heel that we would like to exploit," says Thomas E. Ellenberger, DVM, PhD, the Raymond H. Wittcoff Professor and head of the Department of Biochemistry and Molecular Biophysics at the School of Medicine. "A drug that would stabilize the inactive form of the immunity factor would liberate the toxin in the bacteria."

In this case, the toxin is known as *Streptococcus pyogenes* beta-NAD+ glycohydrolase, or SPN. Last year, coauthor Michael G. Caparon, PhD, professor of molecular microbiology, and his colleagues in the Center for Women's Infectious Disease Research showed that SPN's toxicity stems from its ability to use up all of a cell's stores of NAD+, an essential component in powering cell metabolism. The antitoxin, known as the immunity factor for SPN, or IFS, works by blocking SPN's access to NAD+, protecting the bacteria's energy supply system.

With the structures determined, researchers can now test possible drugs that might force the antitoxin to remain unbound to the toxin, thereby leaving the toxin free to attack its own bacteria.

"The most important aspect of the structure is that it tells us a lot about how the antitoxin blocks the toxin activity and spares the bacterium," says Ellenberger.

Understanding how these bacteria cause disease in humans is important in drug design.
"There is a war going on between bacteria and their hosts," Smith says. "Bacteria secrete toxins and we have ways to counterattack through our immune systems and with the help of antibiotics. But, as bacteria develop antibiotic resistance, we need to develop new generations of antibiotics."
Many types of bacteria have evolved this toxin-antitoxin method of attacking host cells while protecting themselves. But today, there are no classes of drugs that take aim at the protective action of the bacteria's antitoxin molecules.
"Obviously they could evolve resistance once you target the antitoxin," Ellenberger says. "But this would be a new target. Understanding structures is a keystone of drug design."
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Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Washington University School of Medicine**. The original article was written by Julia Evangelou Strait.

Journal Reference:

1. Craig L. Smith, Joydeep Ghosh, Jennifer Stine Elam, Jerome S. Pinkner, Scott J. Hultgren, Michael G. Caparon, Tom Ellenberger. **Structural Basis of Streptococcus pyogenes Immunity to Its NAD^+ Glycohydrolase Toxin**. *Structure*, 2011; 19 (2): 192-202 DOI: 10.1016/j.str.2010.12.013

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An H.I.V. Strategy Invites Addicts In

By DONALD G. McNEIL Jr.

VANCOUVER, British Columbia — At 12 tables, in front of 12 mirrors, a dozen people are fussing intently in raptures of self-absorption, like chorus line members applying makeup in a dressing room.

But these people are drug addicts, injecting themselves with whatever they just bought on the street — under the eyes of a nurse here at Insite, the only "safe injection site" in North America.

"You can tell she just shot cocaine," Thomas Kerr, an AIDS expert who does studies at the center, said of one young woman who keeps readjusting her tight tube top. "The way she's fidgeting, moving her hands over her face — she's tweaking."

Insite, situated on the worst block of an area once home to the fastest-growing AIDS epidemic in North America, is one reason Vancouver is succeeding in lowering new AIDS infection rates while many other cities are only getting worse.

By offering clean needles and aggressively testing and treating those who may be infected with H.I.V., Vancouver is offering proof that an idea that was once controversial actually works: Widespread treatment, while expensive, protects not just individuals but the whole community.

Because antiretroviral medications lower the amount of virus in the blood, those taking them are estimated to be 90 percent less infective.

Pioneering work by the British Columbia Center for Excellence in H.I.V./AIDS at St. Paul's Hospital here demonstrated that getting most of the infected onto the medications could drive down the whole community's rate of new infections.

According to one of the center's studies, financed by the United States National Institutes of Health, from 1996 to 2009 the number of British Columbians taking the medications increased more than sixfold — to 5,413, an estimated 80 percent of those with H.I.V. The number of annual new infections dropped by 52 percent. This happened even as testing increased and syphilis rates kept rising, indicating that people were not switching in droves to condoms or abstinence.

Studies in San Francisco and Taiwan found similar results. So last July the United Nations' AIDS-fighting agency made "test and treat" its official goal — although it acknowledged that it is only a dream, since global AIDS budgets aren't big enough to buy medication even for all those hovering near death.

It is also only a dream in the United States. Much of the American epidemic is now concentrated in poor black and Latino neighborhoods, where health insurance is less common and many avoid testing for fear of being stigmatized. However, the federal government is conducting a three-year study of "test and treat" in the Bronx and the District of Columbia.

Because the three-drug antiretroviral cocktail can have unpleasant side effects, many American doctors delay prescribing it until their patients have low counts of CD4 cells, a sign that their immune systems are weakening. Doctors often feel a greater commitment to each patient's comfort than to the abstract idea of

fewer infections in a given city. But Vancouver is a different story. Canadian medical care is free for the poor, doctors are expected to pursue public health goals and Vancouver's provincial health department aggressively hunts for people to test.

"In 2004, I rebelled when the government people started to say, 'We need to get control over the budget for your program,' " said Dr. Julio S. G. Montaner, director of the St. Paul's program and a former president of the International AIDS Society. "I went to the ministries of finance and health and told them: The best-kept secret in this field is that treatment *is* prevention. You need to let us treat *more* people, not less. And it worked."

Even $50 million spent on drugs, he said, ultimately saves $300 million because roughly 400 people a year avoid infection. (The estimated lifetime cost of treating a Canadian with AIDS is $750,000.)

Dr. Montaner also pushed for the creation of Insite. There, addicts get clean needles, which they are not allowed to share with anyone else.

In return, they are safe from robbery, which is common on the streets outside, and from arrest. Insite has a special exemption from Canada's narcotics laws.

They also know that if they overdose, they won't die. In Insite's seven years of operation, there have been more than 1,000 overdoses inside, but not a single death. (Mild overdoses are treated with oxygen, serious ones with Narcan, an opiate blocker.)

Also, the staff nurses give medical care: They drain and bandage abscesses from dirty needles, hand out condoms, offer gynecological exams and treatment for sexual diseases, refer addicts to treatment and offer AIDS tests.

"We feel very positive about Insite," said Dr. Patricia Daly, chief public health officer for Vancouver Coastal Health, the branch of the health system that covers this part of the country. "There are fewer overdose deaths, less open drug use on the street, and we know it's brought more people into detox."

While the city's large gay community has more infected individuals, the drug-using community is harder to reach. Many addicts are mentally ill or barely educated; many are homeless. About a quarter are American Indians, who have historical reasons to view government testing with suspicion.

Also, addicts are often so consumed with finding their next hit of heroin, cocaine or methamphetamine that they ignore everything else and will sell anything, including their antiretrovirals.

"I love a lot of the people here," said Hugh Lampkin, 48 and a heroin addict since he was 16, as he led a tour of the Downtown Eastside neighborhood. He is vice president of the Vancouver Area Network of Drug Users, an addicts' organization formed in 1997 during a wave of overdose deaths. "You get to know them, they're really decent. But you always have to watch yourself. Everybody is predatory. Drugs make you that way."

Downtown Eastside is a shock even to someone familiar with the Lower East Side of Manhattan in the 1980s or the Tenderloin in San Francisco. Even on a balmy fall afternoon, having 5,000 addicts concentrated in a small neighborhood can make a walk feel like a visit to the set of a zombie movie. On its core blocks, dozens of people are shuffling or staggering, flinching with cocaine tics, scratching scabs. Except for the young women dressed to lure customers for sex, many are in dirt-streaked clothing that hangs from their emaciated frames. Drugs and cash are openly exchanged.

The alleys are worse — people squat to suck on crack pipes, openly undress to find veins or lie down so friends can inject their jugulars — a practice, known as "jugging," that Insite discourages. The puddles, smelling of urine and feces, are sometimes drawn up into syringes, Mr. Lampkin says — one reason that heart infections hospitalize more addicts than overdoses do.

Even in this milieu, where almost everyone admits being a current or former drug user, denial about AIDS is rife.

Admitting that you are H.I.V.-positive, said Ann Livingston, a founder of the drug users' network, means ostracism: forget about sex, and forget about sharing drugs.

Also, Ms. Livingston said, many users are in and out of prison, where it can be dangerous to admit being infected.

The city began handing out free needles in the late 1980s after studies concluded that the practice lowered rates of hepatitis and AIDS. A 1997 study in The Lancet found that in 29 cities worldwide with needle exchange, H.I.V. infection dropped 6 percent a year among drug injectors, while in 51 cities without, it rose by about 6 percent. A Vancouver study found it did the same. In 2003, at the insistence of a new mayor who

was a former police officer and chief coroner, Vancouver went further, opening Insite as a safe haven supervised by nurses.

About 800 injections take place there daily. However, officials think that is only 5 percent of the injections in the city and want permission from the national government to open more sites. “People can’t wait to shoot up,” said Jim Jones, who was handing out syringes at a city-financed “needle depot” in a Downtown Eastside alley. At Insite, Mr. Jones said, “they may have to wait 20 minutes, half an hour. When you’re dope-sick, that’s too long.”

Mr. Lampkin agreed. “People grab a rig, go two feet from here and do their smash,” he said. “Or they don’t even cook up, they shake and bake: pour their drugs right in the syringe, shake it with water, and try to heat the barrel. Shake and bake is how you get endocarditis.”

At Insite, clients are left alone, unless they ask for help. Bad vision is common, and many users have veins clogged with scar tissue. The nurses can help find a vein, “but they cannot push the plunger,” Dr. Kerr said.

Needle litter has decreased in the area, and Insite’s backers assert that violence has gone down, too. Female addicts are often attacked for their drugs or money, Dr. Montaner explained, so they must get men to protect them, which often means payment with sex, which increases infection risk.

Although the Canadian Medical Association and the public health officers of Canada’s 17 largest cities have endorsed supervised sites, no more have opened because the national government refuses to grant more exemptions to the federal narcotics laws.

Insite opened when the Liberal Party was in power. The Conservative-led government that came to power in 2006 has sued to shut it. Local courts have refused to close it, accepting the city’s argument that an addict’s need for opiates is like a diabetic’s for insulin and that a citizen’s right to health — recognized in Canada’s version of the Bill of Rights — outweighs narcotics law.

Canada’s Supreme Court is to take up the case in May.

http://www.nytimes.com/2011/02/08/health/08vancouver.html?_r=1&nl=health&emc=healthupdateema2

Fetal Surgery Helps Spina Bifida, Study Says

By PAM BELLUCK

Jeffrey D. Allred for The New York Times
Doctors say prenatal surgery made a significant difference for Tyson Thomas, with his mother, Jessica

For years, surgeons have been trying to find ways of operating on babies in the womb, reasoning that medical abnormalities might be more easily fixed while a fetus is still developing. But with tremendous risks to babies and mothers, and a mixed record of success, fetal surgery is mostly used when babies are likely to die otherwise.

Now, for the first time, a rigorous clinical trial shows fetal surgery can help babies with a condition that is not life-threatening. Babies with a form of spina bifida, a debilitating spinal abnormality, were more likely to walk and experience fewer neurological problems if operated on before instead of after being born.

The $22.5 million study, long awaited by experts and published online Wednesday in The New England Journal of Medicine, is likely to galvanize interest in trying to address problems before birth, including operating on serious heart defects and bladder blockages, and potentially using fetal bone marrow or stem cell transplants for sickle cell anemia and immune disorders.

"It's a good start, a step in the right direction," said Dr. Joe Leigh Simpson, an obstetrician and geneticist at Florida International University, who wrote an editorial that accompanied the research. "It showed improvement and that there's reason to continue looking for a better mousetrap."

Still, he said, "the improvement that was hoped for, the home run or the holy grail" of eliminating all major problems "obviously did not occur."

And as technology increasingly allows doctors to diagnose problems in a developing fetus, the study underscores remaining risks and hurdles, including developing less-invasive techniques to avoid creating other problems for babies or mothers.

The spina bifida procedure was considered beneficial enough that an independent safety monitoring board stopped the study early so babies scheduled to receive surgery after birth could have access to prenatal surgery.

But there were medical downsides for the women and infants: greater likelihood of being born several weeks earlier than the postnatal group, related breathing problems, and thinning or tearing at women's surgical incisions, requiring Caesarean sections for later births.

"While this is a very promising and quite exciting result," said a study author, Dr. Diana Farmer, surgeon in chief at the Benioff Children's Hospital at the University of California, San Francisco, "not all the patients were helped here, and there are significant risks. This procedure is not for everyone."

Conducting the study was itself challenging. Prenatal spina bifida surgery gained attention in the late 1990s when some medical centers, like Vanderbilt University, began performing it. A photograph in which a fetus's hand appeared to be gripping the finger of a surgeon who had lifted the hand out of the womb was circulated by opponents of abortion rights, further raising the profile.

Leading experts suggested a clinical trial to determine if prenatal surgery was better than postnatal. They insisted on an unusual agreement: that all but three hospitals, in Philadelphia, San Francisco and Nashville, stop doing the procedure.

"There were lots of places that wanted to do it" amid pressure from eager patients, said Dr. Michael Harrison, who pioneered fetal surgery at the University of California, San Francisco, and was a principal investigator for the spina bifida trial before retiring. "But we wanted to make sure it wouldn't become a freak show. And if you offer treatment outside the trial, you'll never have a trial because no mother would agree to flip a coin." Ultimately the other hospitals acceded.

One reason spina bifida researchers wanted a trial was the experience with prenatal surgery for a condition in which the diaphragm has life-threatening abnormalities.

After early attempts at repairing the condition prenatally, "we thought we were heroes," Dr. Harrison said, but realized it worked only for milder cases. Another prenatal approach, forcing the lungs to grow, worked, but caused significantly premature births, making it no better than postnatal treatment, he said. He added that prenatal techniques have improved, becoming less harmful.

The spina bifida study involved the most severe form, myelomeningocele (MY-ell-oh-men-NING-guh-seal), in which the spine does not close properly and the spinal cord protrudes. Children may experience lower-body paralysis, fluid on the brain, bladder problems and learning disabilities. About one in 3,000 children have that form, said Dr. Alan Guttmacher, director of the National Institute of Child Health and Human Development, which financed and helped conduct the study.

Currently, many babies receive surgery to close the spinal opening after birth, but nerve damage from the spinal cord exposure to amniotic fluid remains. Also, the brainstem may be pulled into the spinal column. Excess fluid in the brain may require draining with implanted shunts, which can lead to infection or need repeated surgical replacement.

In the study, about 80 babies got surgery after birth; another 80 had the spinal opening surgically closed in utero, between 19 and 26 weeks of pregnancy. Two in each group died.

Before surgery, babies in the prenatal group had more severe spinal lesions than the postnatal group, but more of the prenatal surgery babies had better results, said a co-author, Dr. Scott Adzick, chief of pediatric surgery at Children's Hospital of Philadelphia.

Those who received prenatal surgery were half as likely to have a shunt, and eight times as likely to have a normally positioned brainstem. There was "much better motor function of the legs," Dr. Adzick said, and at 30 months old, nearly twice as many walked without crutches or orthotics.

Although they were born at 34 weeks of pregnancy on average, compared with 37 weeks for the postnatal group, there was no difference in cognitive development, said Dr. Catherine Spong, chief of pregnancy and perinatology at the child health institute.

Dr. Adzick said prenatal surgery may "stop exposure of the developing spinal cord and perhaps avert further neurological damage" or stop the leak of spinal fluid that causes brainstem problems.

Results were dramatic for Tyson Thomas, of Stansbury Park, Utah, now 22 months old. His mother, Jessica Thomas, said doctors had described his brain malformation as "the worst they had ever seen" and said "it would be likely that he wouldn't be able to breathe on his own."

Since birth at 35 weeks gestation, she said, Tyson breathes independently, shows no brainstem malformation and is starting to talk. Bladder nerve damage will require him to urinate through catheters all his life. He now uses a walker and a foot brace, but is "getting really close to walking" on his own, said Ms. Thomas, a nurse. Researchers will follow the children from ages 6 to 9 to see if benefits continue.

Several experts said they would now mention prenatal surgery as one option for some women. But since many women were excluded from the study, including those who were severely obese or whose babies' conditions did not fit certain specifications, many may be ineligible.

The study should not propel surgeons to "run around and start doing this" for other conditions, said Dr. Terry Buchmiller, a fetal medicine expert at Children's Hospital Boston who was not involved in the research. "I can go in utero right now and fix a cleft lip, but I don't think anybody is saying we ought to do that, because of the risk."

But she called the study "a wonderful, almost several-decade journey of trying to improve the outcomes of a debilitating condition. This looks to be potentially life-changing."

http://www.nytimes.com/2011/02/10/health/10fetal.html?ref=health

Weighing the Evidence on Exercise

By GRETCHEN REYNOLDS

James Welling for The New York Times

How exercise affects body weight is one of the more intriguing and vexing issues in physiology. Exercise burns calories, no one doubts that, and so it should, in theory, produce weight loss, a fact that has prompted countless people to undertake exercise programs to shed pounds. Without significantly changing their diets, few succeed. "Anecdotally, all of us have been cornered by people claiming to have spent hours each week walking, running, stair-stepping, etc., and are displeased with the results on the scale or in the mirror," wrote Barry Braun, an associate professor of kinesiology at the University of Massachusetts at Amherst, in the American College of Sports Medicine's February newsletter.

But a growing body of science suggests that exercise does have an important role in weight loss. That role, however, is different from what many people expect and probably wish. The newest science suggests that exercise alone will not make you thin, but it may determine whether you stay thin, if you can achieve that state. Until recently, the bodily mechanisms involved were mysterious. But scientists are slowly teasing out exercise's impact on metabolism, appetite and body composition, though the consequences of exercise can vary. Women's bodies, for instance, seem to react differently than men's bodies to the metabolic effects of exercise. None of which is a reason to abandon exercise as a weight-loss tool. You just have to understand what exercise can and cannot do.

"In general, exercise by itself is pretty useless for weight loss," says Eric Ravussin, a professor at the Pennington Biomedical Research Center in Baton Rouge, La., and an expert on weight loss. It's especially useless because people often end up consuming more calories when they exercise. The mathematics of weight loss is, in fact, quite simple, involving only subtraction. "Take in fewer calories than you burn, put yourself in negative energy balance, lose weight," says Braun, who has been studying exercise and weight loss for years. The deficit in calories can result from cutting back your food intake or from increasing your energy output —

the amount of exercise you complete — or both. When researchers affiliated with the Pennington center had volunteers reduce their energy balance for a study last year by either cutting their calorie intakes by 25 percent or increasing their daily exercise by 12.5 percent and cutting their calories by 12.5 percent, everyone involved lost weight. They all lost about the same amount of weight too — about a pound a week. But in the exercising group, the dose of exercise required was nearly an hour a day of moderate-intensity activity, what the federal government currently recommends for weight loss but "a lot more than what many people would be able or willing to do," Ravussin says.

At the same time, as many people have found after starting a new exercise regimen, working out can have a significant effect on appetite. The mechanisms that control appetite and energy balance in the human body are elegantly calibrated. "The body aims for homeostasis," Braun says. It likes to remain at whatever weight it's used to. So even small changes in energy balance can produce rapid changes in certain hormones associated with appetite, particularly acylated ghrelin, which is known to increase the desire for food, as well as insulin and leptin, hormones that affect how the body burns fuel.

The effects of exercise on the appetite and energy systems, however, are by no means consistent. In one study presented last year at the annual conference of the American College of Sports Medicine, when healthy young men ran for an hour and a half on a treadmill at a fairly high intensity, their blood concentrations of acylated ghrelin fell, and food held little appeal for the rest of that day. Exercise blunted their appetites. A study that Braun oversaw and that was published last year by The American Journal of Physiology had a slightly different outcome. In it, 18 overweight men and women walked on treadmills in multiple sessions while either eating enough that day to replace the calories burned during exercise or not. Afterward, the men displayed little or no changes in their energy-regulating hormones or their appetites, much as in the other study. But the women uniformly had increased blood concentrations of acylated ghrelin and decreased concentrations of insulin after the sessions in which they had eaten less than they had burned. Their bodies were directing them to replace the lost calories. In physiological terms, the results "are consistent with the paradigm that mechanisms to maintain body fat are more effective in women," Braun and his colleagues wrote. In practical terms, the results are scientific proof that life is unfair. Female bodies, inspired almost certainly "by a biological need to maintain energy stores for reproduction," Braun says, fight hard to hold on to every ounce of fat. Exercise for many women (and for some men) increases the desire to eat.

Thankfully there has lately been some more encouraging news about exercise and weight loss, including for women. In a study published late last month in The Journal of the American Medical Association, researchers from Harvard University looked at the weight-change histories of more than 34,000 participants in a women's health study. The women began the study middle-aged (at an average of about 54 years) and were followed for 13 years. During that time, the women gained, on average, six pounds. Some packed on considerably more. But a small subset gained far less, coming close to maintaining the body size with which they started the study. Those were the women who reported exercising almost every day for an hour or so. The exercise involved was not strenuous. "It was the equivalent of brisk walking," says I-Min Lee, a researcher at Harvard Medical School and Brigham and Women's Hospital and the lead author of the study. But it was consistently engaged in over the years. "It wasn't something the women started and stopped," Lee says. "It was something they'd been doing for years." The women who exercised also tended to have lower body weights to start with. All began the study with a body-mass index below 25, the high end of normal weight. "We didn't look at this, but it's probably safe to speculate that it's easier and more pleasant to exercise if you're not already heavy," Lee says.

On the other hand, if you can somehow pry off the pounds, exercise may be the most important element in keeping the weight off. "When you look at the results in the National Weight Control Registry," Braun says, "you see over and over that exercise is one constant among people who've maintained their weight loss." About 90 percent of the people in the registry who have shed pounds and kept them at bay worked out, a result also seen in recent studies. In one representative experiment from last year, 97 healthy, slightly overweight women were put on an 800-calorie diet until they lost an average of about 27 pounds each. Some of the women were then assigned to a walking program, some were put on a weight-training regimen and others were assigned no exercise; all returned to their old eating habits. Those who stuck with either of the exercise programs regained less weight than those who didn't exercise and, even more striking, did not regain weight around their middles. The women who didn't exercise regained their weight and preferentially packed

on these new pounds around their abdomens. It's well known that abdominal fat is particularly unhealthful, contributing significantly to metabolic disruptions and heart disease.

Scientists are "not really sure yet" just how and why exercise is so important in maintaining weight loss in people, Braun says. But in animal experiments, exercise seems to remodel the metabolic pathways that determine how the body stores and utilizes food. For a study published last summer, scientists at the University of Colorado at Denver fattened a group of male rats. The animals already had an inbred propensity to gain weight and, thanks to a high-fat diet laid out for them, they fulfilled that genetic destiny. After 16 weeks of eating as much as they wanted and lolling around in their cages, all were rotund. The scientists then switched them to a calorie-controlled, low-fat diet. The animals shed weight, dropping an average of about 14 percent of their corpulence.

Afterward the animals were put on a weight-maintenance diet. At the same time, half of them were required to run on a treadmill for about 30 minutes most days. The other half remained sedentary. For eight weeks, the rats were kept at their lower weights in order to establish a new base-line weight.

Then the fun began. For the final eight weeks of the experiment, the rats were allowed to relapse, to eat as much food as they wanted. The rats that had not been running on the treadmill fell upon the food eagerly. Most regained the weight they lost and then some.

But the exercising rats metabolized calories differently. They tended to burn fat immediately after their meals, while the sedentary rats' bodies preferentially burned carbohydrates and sent the fat off to be stored in fat cells. The running rats' bodies, meanwhile, also produced signals suggesting that they were satiated and didn't need more kibble. Although the treadmill exercisers regained some weight, their relapses were not as extreme. Exercise "re-established the homeostatic steady state between intake and expenditure to defend a lower body weight," the study authors concluded. Running had remade the rats' bodies so that they ate less.

Streaming through much of the science and advice about exercise and weight loss is a certain Puritan streak, a sense that exercise, to be effective in keeping you slim, must be of almost medicinal dosage — an hour a day, every day; plenty of brisk walking; frequent long runs on the treadmill. But the very latest science about exercise and weight loss has a gentler tone and a more achievable goal. "Emerging evidence suggests that - unlike bouts of moderate-vigorous activity, low-intensity ambulation, standing, etc., may contribute to daily energy expenditure without triggering the caloric compensation effect," Braun wrote in the American College of Sports Medicine newsletter.

In a completed but unpublished study conducted in his energy-metabolism lab, Braun and his colleagues had a group of volunteers spend an entire day sitting. If they needed to visit the bathroom or any other location, they spun over in a wheelchair. Meanwhile, in a second session, the same volunteers stood all day, "not doing anything in particular," Braun says, "just standing." The difference in energy expenditure was remarkable, representing "hundreds of calories," Braun says, but with no increase among the upright in their blood levels of ghrelin or other appetite hormones. Standing, for both men and women, burned multiple calories but did not ignite hunger. One thing is going to become clear in the coming years, Braun says: if you want to lose weight, you don't necessarily have to go for a long run. "Just get rid of your chair."

Gretchen Reynolds writes the Phys Ed column for the magazine. She is writing a book about the frontiers of fitness.

http://www.nytimes.com/2010/04/18/magazine/18exercise-t.html

Is Marriage Good for Your Health?

By TARA PARKER-POPE

In 1858, a British epidemiologist named William Farr set out to study what he called the "conjugal condition" of the people of France. He divided the adult population into three distinct categories: the "married," consisting of husbands and wives; the "celibate," defined as the bachelors and spinsters who had never married; and finally the "widowed," those who had experienced the death of a spouse. Using birth, death and marriage records, Farr analyzed the relative mortality rates of the three groups at various ages. The work, a groundbreaking study that helped establish the field of medical statistics, showed that the unmarried died from disease "in undue proportion" to their married counterparts. And the widowed, Farr found, fared worst of all.

Farr's was among the first scholarly works to suggest that there is a health advantage to marriage and to identify marital loss as a significant risk factor for poor health. Married people, the data seemed to show, lived longer, healthier lives. "Marriage is a healthy estate," Farr concluded. "The single individual is more likely to be wrecked on his voyage than the lives joined together in matrimony."

While Farr's own study is no longer relevant to the social realities of today's world — his three categories exclude couples living together, gay couples and the divorced, for instance — his overarching finding about the health benefits of marriage seems to have stood the test of time. Critics, of course, have rightly cautioned about the risk of conflating correlation with causation. (Better health among the married sometimes simply reflects the fact that healthy people are more likely to get married in the first place.) But in the 150 years since Farr's work, scientists have continued to document the "marriage advantage": the fact that married people, on average, appear to be healthier and live longer than unmarried people.

Contemporary studies, for instance, have shown that married people are less likely to get pneumonia, have surgery, develop cancer or have heart attacks. A group of Swedish researchers has found that being married or cohabiting at midlife is associated with a lower risk for dementia. A study of two dozen causes of death in the Netherlands found that in virtually every category, ranging from violent deaths like homicide and car

accidents to certain forms of cancer, the unmarried were at far higher risk than the married. For many years, studies like these have influenced both politics and policy, fueling national marriage-promotion efforts, like the Healthy Marriage Initiative of the U.S. Department of Health and Human Services. From 2006 to 2010, the program received $150 million annually to spend on projects like "divorce reduction" efforts and often cited the health benefits of marrying and staying married.

But while it's clear that marriage is profoundly connected to health and well-being, new research is increasingly presenting a more nuanced view of the so-called marriage advantage. Several new studies, for instance, show that the marriage advantage doesn't extend to those in troubled relationships, which can leave a person far less healthy than if he or she had never married at all. One recent study suggests that a stressful marriage can be as bad for the heart as a regular smoking habit. And despite years of research suggesting that single people have poorer health than those who marry, a major study released last year concluded that single people who have never married have better health than those who married and then divorced.

All of which suggests that while Farr's exploration into the conjugal condition pointed us in the right direction, it exaggerated the importance of the institution of marriage and underestimated the quality and character of the marriage itself. The mere fact of being married, it seems, isn't enough to protect your health. Even the Healthy Marriage Initiative makes the distinction between "healthy" and "unhealthy" relationships when discussing the benefits of marriage. "When we divide good marriages from bad ones," says the marriage historian Stephanie Coontz, who is also the director of research and public education for the Council on Contemporary Families, "we learn that it is the relationship, not the institution, that is key."

Some of today's most interesting research on the relationship between marriage and health is being led by a pair of researchers at Ohio State University College of Medicine. The duo, Ronald Glaser and Jan Kiecolt-Glaser, are also, fittingly, married to each other.

Glaser and Kiecolt-Glaser's scholarly collaboration has its roots in a chance encounter during a faculty picnic in October 1978 on the Ohio State campus. Glaser, who is a viral immunologist, spotted an attractive woman standing with members of the psychiatry faculty. Although their eyes met only briefly, he caught a glimpse of her name tag. Intrigued, he tried to track her down, calling the psychiatry department chairman to ask if he knew a petite blonde on staff with a name like "Pam Kiscoli." The department chairman figured out that Glaser was talking about a new assistant professor named Jan Kiecolt. Glaser and Kiecolt eventually met for lunch at the university's hospital cafeteria. They married a year later, in January 1980.

The coupling resulted in more than romance. The two scientists were fascinated by each other's work, which they often discussed over meals or while jogging together. Glaser suggested that they collaborate professionally, but finding common ground was a challenge: he studied virology and immunology; she was a clinical psychologist who focused on assertiveness and other behavior. In the early 1980s, however, Kiecolt-Glaser came across a book on the emerging field of psychoneuroimmunology, which concerns the interplay between behavior, the immune and endocrine systems and the brain and nervous system. The couple were intrigued by a science that lay at the intersection of their disciplines. Today, the two disagree on exactly how their professional collaboration began. "He says I started it," Kiecolt-Glaser told me. "But I say he started it."

In their first research collaboration, they sought to measure the effect of psychological stress on the immune system. Although earlier studies had established that trauma and other major stress — like the death of a loved one or prolonged sleep deprivation — weakened the immune system, the Glasers wanted to know if lesser forms of stress, like those associated with the workplace or graduate school, had a similar effect.

The Glasers, who worked at Ohio's State's medical school, had ready access to an ample supply of stressed-out students, and so they decided to study the toll exacted by school pressure. They took blood samples from a set of students early in the semester and then did so again in the middle of final exams. The Glasers discovered that the stress of examination time seemed to cause a significant weakening of the students' immune response: by examination time, the medical students showed a significant drop in so-called natural killer cells, a type of white blood cell that battles viruses and helps prevent cancer.

For their second collaboration, the Glasers turned their attention to domestic strife. They wondered about the role that relationships play in health and about the effects of marital stress, which, like school pressure, can be a source of nontraumatic but chronic strain. In what was to be the first of their many studies on marriage and health, the Glasers recruited 76 women, half of whom were married; the other half were separated or had divorced. The Glasers wanted to identify which married women were in troubled relationships as well as which of the women who were separated or divorced from their husbands were emotionally struggling the

most. They did this by using marital-quality scales, types of questionnaires that ask couples to indicate agreement or disagreement with statements like "If I had to do it over again, I would marry the same person" or "We often do things together." Next, using blood tests, the Glasers measured the women's immune-system responses, tracking their levels of antibody production and other indicators of immunity strength. The results showed that the women in unhappy relationships and the women who remained emotionally hung up on their ex-husbands had decidedly weaker immune responses than the women who were in happier relationships (or were happily out of them).

Though pleased with this study, the Glasers knew that they had succeeded in taking the measure of marital happiness and health only at a single moment. The couple were also curious to study the effect of marital stress as it unfolded in real time. What happens to the body minute by minute, hour by hour, when couples engage in hostile marital disputes? To find this out, they recruited a study group of 90 seemingly happy newlywed couples. Each couple was hooked up to tubes so that blood samples could be drawn from the pair at regular intervals, and the husband and wife were seated face to face. Obscured by a curtain, the researchers watched the couples on video monitors; nurses took the blood samples. The participants, as they had been prompted to do, discussed their most volatile topics of marital conflict, like housework, sex or interference from a mother-in-law. "You wouldn't think in a study situation that they would tear into each other," Glaser, who is now the director of the Institute for Behavioral Medicine Research, told me. "But they get into it." As expected, the couples who exhibited the most negative and hostile behavior during the conflict discussion showed the largest declines in immune-system function during the 24-hour study period.

These data strongly suggested that marital stress could affect the body in striking ways, but the Glaser team had yet to prove that marital conflict had any truly meaningful or lasting effect on health. Kiecolt-Glaser had an idea for another study that would meet this higher standard. She had read about a strange tool used by her dermatology colleagues: a small plastic suction device designed to leave eight tiny blisters on the arm and allow monitoring of the immune-system response at the wound sites. Kiecolt-Glaser's proposal was to use this blistering device to measure how quickly or slowly physical wounds healed among married couples who had undergone different levels of marital stress.

The experiment had two phases. Each married couple, after their forearms were subjected to the blistering procedure, were asked to talk together for a half-hour: on one occasion they discussed topics chosen to elicit the couples' supportive behaviors; on another day, after undergoing the blistering procedures again, they discussed topics selected to evoke conflict and tension and tried to resolve them. Before subjecting others to the blistering regimen, each of the Glasers had the device secured to his or her respective forearm to have his or her skin blistered. The sensation is comparable to "someone gently pinching your arm," Kiecolt-Glaser told me. Nonetheless, the Glasers knew it would be a tough sell to convince others couples to undergo the blistering procedure as well as two weeks of subsequent monitoring of the wounds as they healed. A study grant allowed them to offer $2,000 in total compensation to any couple willing to take part in the experiment. They managed to recruit 42 married couples for the study.

The results were remarkable. After the blistering sessions in which couples argued, their wounds took, on average, a full day longer to heal than after the sessions in which the couples discussed something pleasant. Among couples who exhibited especially high levels of hostility while bickering, the wounds took a full two days longer to heal than those of couples who had showed less animosity while fighting.

Published in 2005 in The Archives of General Psychiatry, the Glasers' findings help explain epidemiological data showing that couples in troubled marriages appear to be more susceptible to illness than happier couples. The results may also have practical relevance for surgical patients, for instance, waiting for incisions to heal. But most important, the study offered compelling evidence that a hostile fight with your husband or wife isn't just bad for your relationship. It can have a profound toll on your body.

Kiecolt-Glaser told me that the overall health lesson to take away from the new wave of marriage-and-health literature is that couples should first work to repair a troubled relationship and learn to fight without hostility and derision. But if staying married means living amid constant acrimony, from the point of view of your health, "you're better off out of it," she says.

Last year, The Journal of Health and Social Behavior published a study tracking the marital history and health of nearly 9,000 men and women in their 50s and 60s. The study, which grew out of work by researchers at the University of Chicago, found that when the married people became single again — either by divorce or because of the death of a spouse — they suffered a decline in physical health from which they never fully

recovered. These men and women had 20 percent more chronic health issues, like heart disease and diabetes, than those who were still married to their first husband or wife by middle age. The divorced and widowed also had aged less gracefully, reporting more problems going up and down stairs or walking longer distances.
Perhaps the most striking finding concerned single people who had never married. For more than 100 years, scientists have speculated that single people, because they generally have fewer resources, lower income and perhaps less logistical and emotional support, have poorer health than the married. But in the Chicago study, people who had divorced or been widowed had worse health problems than men and women who had been single their entire lives. In formerly married individuals, it was as if the marriage advantage had never existed.
Does marrying again benefit those who divorce, in terms of health? In the Chicago study, remarriage helped only a little. It seemed to heal emotional wounds: the remarried had about the same risk for depression as the continuously married. But a second marriage didn't seem to be enough to repair the physical damage associated with marital loss. Compared with the continuously married, people in second marriages still had 12 percent more chronic health problems and 19 percent more mobility problems. "I don't think anyone would encourage people to stay in a marriage that is really making them miserable," says Linda J. Waite, a University of Chicago sociologist and an author of the study. "But try harder to make it better." Even if marital problems seem small, Waite says, the data suggest it's wise to intervene early and try to resolve them. "If you learn to how to manage disagreement early," she says, "then you can avoid the decline in marital happiness that follows from the drip, drip of negative interactions."
Other researchers have also studied how the "drip, drip" of negativity can erode not only a marriage itself but also a couple's physical health. A number of epidemiological studies suggest that unhappily married couples are at higher risk for heart attacks and cardiovascular disease than happily married couples. In 2000, The Journal of the American Medical Association published a three-year Swedish study of 300 women who had been hospitalized with severe chest pains or a heart attack; the study found that those who reported the highest levels of marital stress were nearly three times as likely to suffer another heart attack or require a bypass or other procedure. It is notable that these increased risks weren't associated with other forms of stress. For instance, women who were stressed-out at work weren't at any higher risk for a second episode of heart problems than women who were happy in their jobs.
Of course, all couples — happy or unhappy — are bound to experience some form of marital conflict. Surely this does not mean everyone is doomed to ill health; some conflicts are better than others. The University of Utah psychology professor Timothy W. Smith has addressed this question, studying how what he calls the "emotional tone" of conflict affects heart risk. In one study, he recruited 150 couples, most of whom were in their 60s and married for an average of 36 years. All were in general good health with no signs of heart disease. Smith collected video recordings of the couples discussing stressful topics like money management or housework. The arguments were then "coded" to indicate the number of warm, hostile and controlling statements and words that were used in the course of the dispute. In addition, the couples were put in heart-scanning machines to measure coronary calcium levels, which are a useful indicator of heart-disease risk. Smith then compared each person's conflict style with their coronary calcium score.
Smith's results suggest that there are important differences between men and women when it comes to health and the style of conflict that can jeopardize it. The women in his study who were at highest risk for signs of heart disease were those whose marital battles lacked any signs of warmth, not even a stray term of endearment during a hostile discussion ("*Honey*, you're driving me crazy!") or a minor pat on the back or squeeze of the hand, all of which can signal affection in the midst of anger. "Most of the literature assumes that it's how bad the arguments get that drives the effect, but it's actually the lack of affection that does it," Smith told me. "It wasn't how much nasty talk there was. It was the lack of warmth that predicted risk."
For men, on the other hand, hostile and negative marital battles seemed to have no effect on heart risk. Men were at risk for a higher coronary calcium score, however, when their marital spats turned into battles for *control*. It didn't matter whether it was the husband or wife who was trying to gain control of the matter; it was merely any appearance of controlling language that put men on the path of heart disease.
In both cases, the emotional tone of a marital fight turned out to be just as predictive of poor heart health as whether the individual smoked or had high cholesterol. It is worth noting that the couples in Smith's study were all relatively happy. These were husbands and wives who loved each other. Yet many of them had developed styles of conflict that took a physical toll on each other. The solution, Smith noted, isn't to stop

fighting. It's to fight more thoughtfully. "Difficulties in marriage seem to be nearly universal," he said. "Just try not to let fights be any nastier than they need to be."

Researchers have also started to examine the salutary health effects of social relationships, including those of a good marriage. In one recent study, James A. Coan, an assistant professor of psychology and a neuroscientist at the University of Virginia, recruited 16 women who scored relatively high on a questionnaire assessing marital happiness. He placed each woman in three different situations while monitoring her brain with an f.M.R.I. machine, which offers a way to observe the brain's response to almost any kind of emotional stimulation. In one situation, to simulate stress, he subjected the woman to a mild electric shock. In a second, the shock was administered, but the woman held the hand of a stranger; in a third, the hand of her husband. Both instances of hand-holding reduced the neural activity in areas of the woman's brain associated with stress. But when the woman was holding her husband's hand, the effect was even greater, and it was particularly pronounced in women who had the highest marital-happiness scores. Holding a husband's hand during the electric shock resulted in a calming of the brain regions associated with pain similar to the effect brought about by use of a pain-relieving drug.

Coan says the study simulates how a supportive marriage and partnership gives the brain the opportunity to outsource some of its most difficult neural work. "When someone holds your hand in a study or just shows that they are there for you by giving you a back rub, when you're in their presence, that becomes a cue that you don't have to regulate your negative emotion," he told me. "The other person is essentially regulating your negative emotion but without your prefrontal cortex. It's much less wear and tear on us if we have someone there to help regulate us."

With so much evidence establishing a link between marital stress and health, a new generation of research is set to explore the ways in which couples can mitigate the damaging effects of relationship stress. The Glasers are now conducting studies testing whether regular supplements of fish oil, rich in omega-3 fatty acids, can mitigate some of the physical symptoms of stress on the immune system.

The couple are also embarking on a new study looking at the interplay between nutrition and marital stress. Earlier research at Ohio State showed that when study subjects were given intravenous fat injections during times of stress, it took longer for triglycerides, fats that are associated with heart disease, to leave the bloodstream. But Kiecolt-Glaser is more interested in the real-world equivalent of the study: What happens to the body's ability to cope with fats when couples fight at dinnertime? To find out, she's planning to feed married couples two types of meals — one relatively healthful meal and one high-fat meal equivalent to fast food. During the meal the couples will be asked to discuss topics of high stress, and a blood analysis will offer a glimpse of the effect that mealtime conflict has on the body's ability to metabolize fats. "It's an ideal way," Kiecolt-Glaser says, "to look at what happens to couples in the real world, where so many family conflicts happen over a meal."

For the Glasers, their nearly 30 years of professional collaboration have not only given them new insights into the role of stress and health but have also helped them in their own marriage. Like every married couple, they have their disagreements, Glaser told me. But years of watching married couples interact and measuring the subsequent physical toll that conflict takes on their bodies has taught the Glasers the importance of taking time off together and making sure their disagreements don't degenerate into personal attacks. "Don't fight dirty," he advised. "You never go far enough down the road where you hurt each other. We know enough to avoid those kinds of arguments."

Kiecolt-Glaser added that the couple's research shows that some level of relationship stress is inevitable in even the happiest marriages. The important thing, she said, is to use those moments of stress as an opportunity to repair the relationship rather than to damage it. "It can be so uncomfortable, even in the best marriages, to have an ongoing disagreement," she said. "It's the pit-in-your-stomach kind of thing. But when your marital relationship is the key relationship in your life, a disagreement is really a signal to try to fix something."

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The Estrogen Dilemma

By CYNTHIA GORNEY

Photo illustration by Alex Prager for The New York Times

Here we are, two fast-talking women on estrogen, staring at a wall of live mitochondria from the brain of a rat. Mitochondria are cellular energy generators of unfathomably tiny size, but these are vivid and big because they were hit with dye in a petri dish and enlarged for projection purposes. They're winking and zooming, like shooting stars. "Oh, my God," Roberta Diaz Brinton said. "Look at that one. I love these. I love shooting mitochondria."

Brinton is a brain scientist. Estrogen, particularly in its relationship to the health of the brain, is her obsession. At present it is mine too, but for more selfish reasons. We're inside a darkened lab room in a research facility at the University of Southern California, where Brinton works. We are both in our 50s. I use estrogen, by means of a small oval patch that adheres to my skin, because of something that began happening to me nine years ago — to my brain, as a matter of fact. Brinton uses estrogen and spends her work hours experimenting with it because of her own brain and also that of a woman whose name, Brinton will say, was Dr. A. She's dead now, this Dr. A. But during the closing years of her life she had Alzheimer's, and Brinton would visit her in the hospital. Dr. A. was a distinguished psychotherapist and had vivid stories she could still call to mind about her years in Vienna amid the great European psychologists. "We'd spend hours, me listening to her stories, and I'd walk out of the room," Brinton told me. "Thirty seconds later, I'd walk back in. I'd say, 'Dr. A., do you remember me?' And she was so lovely. She'd say: 'I'm so sorry. Should I?' "

The problem with the estrogen question in the year 2010 is that you set out one day to ask it in what sounds like a straightforward way — Yes or no? Do I or do I not go on sticking these patches on my back? Is

hormone replacement as dangerous in the long term as people say it is? — and before long, warring medical articles are piling up, researchers are raising their voices and gesticulating excitedly and eventually you're in Los Angeles staring at a fluorescent rodent brain in the dark. "You want a statistic?" Brinton asked softly. Something about the shooting mitochondria has made us reverent. "Sixty-eight percent of all victims of Alzheimer's are women. Is it just because they live longer? Let's say it is, for purposes of discussion. Let's say it's just because these ladies get old. Do we just say, 'Who cares?' and move them into a nursing home? Or alternatively, maybe they are telling us something."

With their brains, she means. Their sputtering, fading Alzheimer's brains, which a few decades earlier were maybe healthy brains that might have been protected from eventual damage if those women had taken estrogen, and taken it *before* they were long past their menopause, while their own neural matter still looked as vigorous as those rat cells on the wall. This proposition, that estrogen's effects on our minds and our bodies may depend heavily upon when we first start taking it, is a controversial and very big idea. It has a working nickname: "the timing hypothesis." Alzheimer's is only one part of it. Because the timing hypothesis adds another layer of complication to the current conventional wisdom on hormone replacement, it has implications for heart disease, bone disease and the way all of us women now under 60 or so — the whole junior half of the baby boomers, that is, and all our younger sisters — could end up re-examining, again, everything the last decade was supposed to have taught us about the wisdom of taking hormones.

I first met Brinton at a scientific symposium at Stanford University in January that was entirely devoted to the timing hypothesis. The meeting was called Window of Opportunity of Estrogen Therapy for Neuroprotection, and it drew research scientists and physicians from all over the country. When I asked to listen in, the organizers hesitated; these are colleagues around a conference table, they pointed out. They're probing, interrogating, poking holes in one another's work in progress.

But I was finally permitted to take a chair in a corner, and as the day went on, I became aware of my patch, in a distracted, hallucinatory sort of way, as if I had started fixating on a smallish scar. One after another, their notes and empty coffee cups piling up around them, heart experts and brain experts and mood experts got up to talk about estrogen — experiments, clashing data, suppositions, mysteries. There are new hormone trials under way that are aimed at the 40-year-old to 60-year-old cohort, with first results due in 2012 and 2013. There are depression studies involving estrogen. There are dementia studies involving estrogen. There are menopausal lab monkeys taking estrogen, ovariectomized lab mice taking estrogen and young volunteers undergoing pharmaceutically induced menopause so researchers at the National Institutes of Health can study exactly what happens when the women's estrogen and progesterone are then cranked back up. I typed notes into my laptop for hours, imagining the patch easing its molecules into the skin of my back, and the whole time I was typing, working hard to follow the large estrogen-replacement thoughts of the scientists around the table, I had one small but persistent estrogen-replacement thought of my own: If I make the wrong decision about this, I am so screwed.

I started taking estrogen because I was under the impression that I was going crazy, which turns out to be not as unusual a reaction to midlife hormonal upheaval as I thought. This was in 2001. The year is significant, because the prevailing belief about hormone replacement in 2001 was still, as it had been for a quarter century, the distillation of extensive medical and pharmaceutical-company instruction: that once women start losing estrogen, taking replacement hormones protects against heart disease, cures hot flashes, keeps the bones strong, has happy effects on the skin and sex life and carries a breast-cancer risk that's worth considering but not worrying about too much, absent some personal history of breast cancer or a history of breast cancer in the immediate family.

At first, as I was trying to locate a psychiatrist who would take me on, I wasn't aware I had reason to pay attention to advice about hormones at all. That year I turned 47, a normal age for beginning the drawn-out hormonal-confusion period called perimenopause, but I had none of the familiar signs. Menopausal holdouts run in the family; one of my grandmothers was nearly 60 by the time hers finally kicked in. My only problem was a new tendency to wake up some mornings with a great dark weight shoving my shoulders toward the floor and causing me to weep inside my car and basically haul myself around as if it were the world's biggest effort to stand up straight and carry on a conversation. Except for its having shown up so arbitrarily and then coming and going in waves, there was nothing interesting about my version of what my husband and I came to think of as the Pit; anybody who has been through a depression knows what a stretch of semidisabling despair feels like, and for my part I had a very nice life, a terrific family and a personal interior chorus of

quarreling voices demanding to know why I didn't pull up my socks and carry on, which in fact was the first question I planned to ask a psychiatrist.

But I went to my gynecologist first, so she could check my blood pressure or whatever seemed the prepsychiatrist thing to do. How often would you say you feel this way, she asked; and I said I didn't know, maybe every few weeks; and she told me to start keeping records. Note each day, she said. Check for patterns. She was right. There was a pattern. I was falling into the Pit on schedule, around 11 days before each menstrual period, or M.P., which is one of many abbreviations I was to learn in my efforts to keep track of the ferocious hormones debate that started up in North America in 2002, one year after I stuck on the first estrogen patch that my gynecologist prescribed. The study at the center of the ruckus was called the Women's Health Initiative, or W.H.I. It was a federally financed examination of adult women's health, extraordinary in scale and ambition, that started up in the early 1990s; one of its drug trials enrolled more than 16,000 women for a multiyear comparison of hormone pills versus placebos. On July 9, 2002, W.H.I. investigators announced that they had ended the trial three years early, because they were persuaded that it was dangerous to the hormone-taking participants to let them continue.

The women on hormones were having more heart trouble than their placebo-taking counterparts, the investigators said, not less. Their risk for stroke went up. Their risk for blood clots went up. Their risk for breast cancer increased by 24 percent. The W.H.I. bulletins dominated medical news all summer and long into the fall, and so alarming were their broad-scale warnings that millions of women, myself included, gave up hormone replacement and resolved to forge ahead without it.

The patches my gynecologist prescribed worked, by the way. I didn't understand how, beyond the evident quieting of some vicious recurring hormonal hiccup, and neither did the gynecologist. But she had other women who came in sounding like me and then felt better on estrogen, and I would guess many of them, too, decided after the W.H.I. news that they could surely find other ways to manage their "mood swings," to use the wondrously bland phrasing of the medical texts. (I'm sorry, but only someone who has never experienced one could describe a day of "I would stab everyone I know with a fork if only I could stop weeping long enough to get out of this car" as a "mood swing.") We muddled along patchless, my mood swings and my patient family and I, until there came a time in 2006 when in the midst of some work stress, intense but not unfamiliar, I found myself in a particularly bad Pit episode and this time unable to pull out.

It was profoundly scary. In retrospect, I managed a surprising level of public discretion about what was going on; competence at the cover act is a skill commonly acquired by midlife women, I think, especially those with children and work lives. If the years have taught us nothing else, they have taught us how to do a half dozen things at once, at least a couple of them decently well. Like other women I have met recently with stories like this one, I relied for a few months on locked office doors, emergency midday face-washings and frequent visits to an increasingly concerned talk therapist. But one afternoon I got off my bicycle in the middle of a ride with my husband, because I had been crying so hard that I couldn't see the lane lines, and I sat down on the sidewalk and told him how much I had come to hate knowing that family obligations meant I wasn't allowed to end my life. The urgent-care people at my health clinic arranged a psychiatric consult fast, and after listening and nodding and grabbing scratch paper to draw me an explanatory graph with overlapping lines that peaked and plunged, the psychiatrist wrote me two prescriptions. One was for an antidepressant. The other — I recognized the name as soon as she wrote it down — was for Climara, my old estrogen patch.

By this time we were four years past the 2002 W.H.I. hormone news. So I knew a few more things. I knew there had been a surge of industrious scrambling among former hormone-taking women, some of whom had tried multiple alternatives or going cold turkey and then changed their minds and re-upped on estrogen, deciding that life without it was so unpleasant that they no longer cared what the statistical prognoses said. I knew the prevailing medical sentiment had shifted slightly since the bombshell of 2002; certain articles and books still urged women to shun hormone replacement at all costs, but the more typical revised counsel was, essentially, proceed with great caution. If some menopausal malady is genuinely making you miserable, the new conventional wisdom advised, and no alternative remedy is working for you, then go ahead and take hormones — but keep the dose low and stop them as soon as possible.

I would like to be able to tell you that I weighed these matters thoughtfully, comparing my risks and benefits and bearing in mind the daunting influence of a drug industry that stands to profit handsomely from the medicalizing of normal female aging. But that would be nonsense, of course. I was too crazy. I went straight to the pharmacy and took everything they gave me.

You don't read the fine print on package labels when you're being ushered through a psychiatric crisis, but after a while, I did. By last winter I was nearing the cumulative five-year mark as an estrogen user, and although "low dose, stop soon" is often an advisory without specifics attached, five years seemed to turn up here and there as an informal outer-limit guideline. And because it had worked again, because the estrogen so clearly helped repair something that was breaking (there's no way for me to separate the effects of estrogen from the effects of the antidepressant, except that on the few occasions when I've been haphazard about replacing the estrogen patches on time, I've experienced prompt and unmistakable intimations of oncoming Pit), I now had some rational faculties with which to go looking for explanations that might help me decide what to do. This was when I first began learning that in the controversy over hormone replacement, the fine print matters a very great deal.

First of all, the kind of estrogen in my patches — there are different forms of estrogenic molecules — is called estradiol. It's not the estrogen used in the W.H.I. study. Pharmaceutical estradiol like mine comes from plants whose molecules have been tweaked in labs until they are atom for atom identical to human estradiol, the most prominent of the estrogens premenopausal women produce naturally on their own. The W.H.I. estrogen, by contrast, was a concentrated soup of a pill that is manufactured from the urine of pregnant mares. The drug company Wyeth (now owned by Pfizer) sells it in two patented products, the pills Premarin and Prempro, and it's commonly referred to as "conjugated equine estrogens."

There was more in the fine print. Two years ago, after warning me that women who haven't had a hysterectomy run a higher risk of uterine cancer when they take only estrogen as hormone replacement, a new doctor added in progesterone, which has been shown to protect the uterus. The progesterone he prescribed for me, like the estradiol, is a molecular replica of the progesterone women make naturally. It's different from the progesteronelike synthetic hormone that was used for the W.H.I. study that ended in 2002. That medication was a formulation whose multisyllabic chemical name shortens to MPA and which has a problematic back story of its own: MPA takes care of the uterine-cancer risk, but there's reason to suspect it may be a factor in promoting breast cancer. And it's ingested as a pill, which means that like equine estrogens (and unlike, for example, my patch), MPA metabolizes through the liver, possibly creating additional complications en route, before going about its business.

The biggest difference between me and the W.H.I. women, though, has to do with age and timing. I started on the patches while my own estrogen, pernicious though its spikes and plummets may have been, was still floating around at more or less full strength. The average age of the W.H.I. women was just over 63, though the study accepted women as young as 50. More significant, though, most of them were many years past their final menstrual period, which is the technical definition of menopause, when they began their trial hormones. The bulk of the group was at least 10 years past; factoring in the oldest women, the average number of years between the volunteers' menopause and their start on the trial medications was 13.4.

Because women generally make decisions about hormones while they are in the throes of perimenopause — that term is now used to extend through the year following the final M.P. — you may find this as perplexing as I did. Why would the largest drug trial in the history of women's health select, for most of its participants, women already long past the critical phase? I heard one undiplomatic critic sum up the W.H.I. as "the wrong drugs, tested on the wrong population," and those two factors, the drugs and the population, are actually directly linked. Equine estrogens and MPA were the only forms of hormones used in the W.H.I. trials. Among other reasons, that's because drug trials are expensive; this one was huge, and Wyeth was going to provide without cost an average of eight years' worth of its equine estrogens and MPA to 40 clinical centers.

And millions of women were using those very hormones already, partly because aggressive Wyeth marketing had for three decades insisted that hormone replacement was the ticket to a vigorous and sexually satisfactory postmenopausal life. To a certain extent, evidence backed up that claim; wide-scale though less rigorous earlier studies appeared to demonstrate hormone replacement's benefits so clearly that many physicians were suggesting it almost automatically to midlife women, whether or not they had perimenopausal complaints. Hormones raised the breast-cancer risk in those earlier studies, but nearly every other health factor showed improvement when women who took hormones were compared with those who didn't. Hot flashes disappeared, osteoporosis was milder, women reported feeling better and women who took hormones showed a markedly lower rate of heart disease than women who did not.

Because heart disease ultimately kills many more women than all cancers combined, some doctors had also taken to urging older women, even those past menopause, to start hormones for cardiac-health purposes. The

W.H.I. trials were supposed to provide conclusive evidence, finally, as to whether all this wide-scale prescribing was truly a sound idea. But cardiovascular disease tends to make its bids for attention — its "events," as clinicians say, like heart attack and death — when we're quite a bit past 51, the average age at which American women hit menopause. The only way the W.H.I. was going to tally up a scientifically useful number of cardiac events was to enroll plenty of women already old enough to reach that danger stage before the study's time ran out. So that's what they did, and once the final data was reparsed many times, it was clear that the trial had shown physicians something highly important about the perils of starting older postmenopausal women (that's qualifier No. 1) on pills (No. 2) containing equine estrogens (No. 3) plus MPA (No. 4).

Those four qualifiers make the chief message of the W.H.I. — that taking hormones, in the long run, is more likely to hurt you than help — far more specific than the one most women heard. For those of us not yet on the far side of menopause, or who don't match the other qualifiers (as I write this, for example, I'm zero for four), a daunting proportion of what we thought we learned about hormone replacement over the last eight years remains unsettled, more confusing than ever and conceivably — we don't know yet — wrong. "I mean, if you're a 70-year-old," says S. Mitchell Harman, a Phoenix-based endocrinologist and coordinator of one of the national trials currently examining hormones' effects on younger women, "and your question is, Should I start taking estrogen? the W.H.I. answered that for you beautifully. *No.* Unfortunately, it wasn't designed to answer that question for a 50-year-old. So now we're trying to fill in the blanks."

One afternoon last month, I reported to the Northern California site for an N.I.H.-financed cognitive trial that is part of the Kronos Early Estrogen Prevention Study that Harman is leading. Keeps, as it's called, has enrolled women at nine such sites around the country; this one was inside a medical building at the University of California, San Francisco, and the cognition test I asked to try proved to be a low-tech experience: a table with chairs, pens and pencils and a gentle-voiced psychologist asking me to do things with my brain. Number sequences repeated backward, lists of random objects to recall, designs to remember and copy — I promised not to describe specifics, because making details public could compromise the trial results. But imagine a stranger holding up a stopwatch and giving you 30 seconds to name every dessert item you can think of. The brain charges off into a comical panic grope, and it's like a cross between a back-seat car game and the SATs. The only grading marker, though, is self compared to self. If I were a Keeps participant, I would be on a four-year regimen of some mystery medication — either estrogen, in one of two forms (estradiol patches or equine-estrogen pills, to see whether differences emerge between the two), or placebo patches or placebo pills. Then in another year, I would retake the cognition test, which lasted about an hour and a half, so researchers could track any change. Brain function is a major element of the Keeps agenda; the other is heart health, so the test administrators would conduct annual ultrasounds of my carotid artery, to check for the thickening that signals heart disease. That's how they are trying to circumvent the doesn't-manifest-until-you're-older problem, by measuring for known warning markers rather than waiting for the actual big events. They would check my blood and cholesterol for signs of other cardiovascular trouble.

With about 730 participants, Keeps is relatively small; hormone research has been tough to finance in the post-W.H.I. years, and every scientist and physician I've spoken to said there will never again be another hormone trial as costly and ambitious as the W.H.I. A second study, based in Los Angeles, called the Early Versus Late Intervention Trial With Estradiol, is following more than 600 women — comparing a group that has been post-menopausal for an average of 15 years and that is on estradiol or on a placebo with a second, younger group that is an average of three years post-menopausal. "*This* is the age when we should really study estrogen," says Sanjay Asthana, a University of Wisconsin medical professor who is a designer of the cognition component of Keeps. "People like me are really waiting to see what this data looks like. Either way. We need to know."

Asthana is a geriatrician, with a specialty in Alzheimer's and other forms of age-related memory loss. That makes him a member of what I came to think of, in my travels among estrogen researchers this winter, as the brain contingent. Their working material includes neuroimaging; magnified slices of rodent brains; and live cells that carry on in petri dishes, shooting mitochondria around or struggling under the burden of disease. All these things allow the brain contingent to see, sometimes literally, estrogen in action. It's an amazing process. When cells are healthy, estrogenic molecules slide right in, searching for special receptors that are shaped precisely for the estrogens: the receptors are tiny locks, waiting for the right molecular keys to turn them on. Then, once they are activated by the key-turning process, the work estrogen receptors do is richly complex, if

only partly understood. They prod genes into action; they raise good cholesterol; they affect the neurotransmitter chemicals associated with mood and stress, like serotonin and dopamine.

And the brain, scientists have learned in recent decades, is loaded with these receptors. Knowing this makes it easier to understand how perimenopause could start inside aging ovaries and set off such a wild cascade of effects. If you're a typical woman moving through your 40s or 50s, your lifetime egg supply is running out; as that happens, the intricate, multihormone reproductive-signaling loop grows confounded, its triggers altered by the biology of change. The brain and ovaries, the primary stops along this loop, start misreading each other's demands for action. This can make estrogen production crank up frantically, crash and then crank up again. Something also goes awry with most women's thermoregulatory systems, producing hot flashes in around three-quarters of us — nobody yet knows why, exactly, nor why certain women go on flashing for many years while some escape the whole must-remove-outer-garments-*now* phenomenon entirely. There's an admirably clear explanation of the complete process in a recent book called "Hot Flashes, Hormones and Your Health," by JoAnn Manson, a Harvard medical professor who worked with both W.H.I. and Keeps. My favorite illustration in Manson's book shows an actual woman's hormone fluctuations as measured before, during and after perimenopause; the "before" graph is a row of calm, evenly spaced ups and downs, various hormones rising and falling in counterpoint and on cue. The lines in the "after" graph are virtually flat. The "during" graph looks as if somebody dynamited a mountain range.

Not all women, Manson notes, experience disruptions as robust as this unidentified patient's. But consider the mess of internal rearrangement we're looking at: the body's overall estrogen production is waning as the ovaries start atrophying into full retirement; and here simultaneously, at least for some of us, is this great Upheaval of During. The combination of the two can be — how could it *not*, I thought, the first time I studied the three graphs — a hellacious strain on the brain. Tracing the exact mechanics is still a work in progress, but they surely include some disruption of signaling to the neurotransmitters that make us remember things, experience emotions and generally choreograph the whole thinking operation of the human self.

"There are all these fundamental cognitive functions that many perimenopausal women complain about, and one of those fundamentals is attention," Roberta Brinton, the U.S.C. scientist, told me. "When you can't hold your attention to a thought. Where you're in constant start mode, and you never reach the finish mode. That is devastating."

This was Brinton, as it happens, describing herself. It's why she first went on estrogen (estradiol, accompanied by natural progesterone) when her own perimenopause kicked in a few years ago. We were sitting in a campus garage in her Prius one day, and I asked her what made her so sure her own midlife difficulties — she had the hot flashes, which were obvious, but also the sleep disruption and the infuriating distractibility — were the product of hormonal events, not some womanly existential crisis. We get a lot of that, societally. It's meant to be empathetic. Your role in life is changing, Mrs. Brain Seized by Aliens! Your children are growing up, you're buying expensive wrinkle cream, ice cream makes you gain weight now, of course you're distraught! "Because with estrogen — " Brinton looked at me sharply, and then smiled — "I don't have attention-deficit disorder."

We walked back up to her laboratories, which are spread along a many-roomed warren full of cell incubators, centrifuges and computers. Brinton has thick black hair and a demeanor of lively, good-humored authority; it's easy to envision her as the passionate science professor in crowded lecture halls. But in her labs the work is all rats and mice, many of them surgically or genetically altered to serve as surrogates for adult humans in various stages of maturation or disease. Removing the ovaries from female rats, for example, sends them into low-estrogen mode. Mice can be ordered bred with Alzheimer's. The plaque that clogs the brains of Alzheimer's sufferers, a noxious memory-disrupting substance called beta amyloid, is available as a chemical distillate, which means Brinton's team can experiment with that too — beta amyloid dropped into the brain cells of healthy low-estrogen rodents; or estrogen dropped into cells already damaged by beta amyloid.

That's why Brinton says that the timing hypothesis — the proposition that estrogen could bring great benefit to a woman who starts it in her 50s while having the reverse effect on a woman 10 years older — makes sense even though it is still experimental. She and other scientists know there are ways estrogen improves and protects the brain when it is added to healthy tissue. It makes new cells grow. It increases what's called "plasticity," the brain's ability to change and respond to stimulation. It builds up the density and number of dendritic spines, the barbs that stick out along the long tails of brain cells, like thorns on a blackberry stem,

and hook up with other neurons to transmit information back and forth. (The thinning of those spines is a classic sign of Alzheimer's.)

But when estrogen hits cells that are already sick — because they're dying off as part of the natural aging process or because they've been damaged by beta amyloid — something else seems to happen. Dropped in as a new agent, like the wrong kind of chemical solvent sloshed onto rusting metal, estrogen doesn't strengthen or repair. It appears useless. Sometimes it sets off discernible harm. You may recall additional W.H.I. news a few years ago about hormones increasing the risk for aging-related dementia; those stories emerged from a subgroup of W.H.I. participants who were all at least 65 when they started the hormones. There are arguments about that data, like nearly everything else connected to the W.H.I., but the age factor alone reinforces what Brinton and other timing-hypothesis researchers observe in the labs when they give estrogen to ailing cells. "It's like the estrogen is egging on the negative now, rather than the positive," she said. "We know that if you give neurons estrogen, and then expose them to beta amyloid, many more will survive. But when we expose them to amyloid and *then* give them estrogen — now you don't have survival of the neurons. In some instances, you can actually exacerbate their death."

The heart contingent exploring the timing hypothesis is reasoning the same way. Monkeys get both cardiovascular disease and their own version of menopause; there is a primate team at Wake Forest University in North Carolina that has found estrogen to be a strong protectant for females against future heart disease — but only when it's given at monkey perimenopause. Give estrogen the equivalent of six human years later, says Tom Clarkson, the pathology professor who has been leading this work for decades, and there is no protective effect at all.

Clarkson, who is 78, told me that if he were 30 years younger and a woman, with hot flashes or sleep trouble or sudden crashes of mood, he would have no hesitation about taking hormones. "I absolutely believe in the timing hypothesis," he said. Then, being a scientist, he corrected himself. "I would have to say my level of certainty is 95 percent or greater," he said. "I live a life of believing in the experimental evidence."

So noted, I replied. And what if the symptoms were annoying but bearable or there were no symptoms at all? I've asked the same questions to every researcher I talked to this spring, and nearly all of them reply the same way: if they were deciding for themselves personally, they would tip the risk-benefit scale strongly in favor of hormones as a remedy for immediate ailments of perimenopause. But estrogen solely as a protectant for the heart and brain, to be taken for many years, absent any immediate serious complaints? There was a pause, and I heard Clarkson sigh. "We just don't know about that yet," he said.

The personal calculus of risk is an exhausting exercise in the modern era, what with litigation-jumpy physicians, the researchers' candid "We just don't know" and the bottomless learn-it-yourself maw of the Internet. Of all the conversations I had this winter, as I weighed and reweighed the stopping of the patch, the one that most resonates took place on a snowy morning in Washington, in the office of a nursery-school director named Julia Berry. Berry lives not far from the headquarters of the National Institutes of Health in Bethesda, Md., which is why last September she pulled from her mailbox a card the N.I.H. has been mailing to local women within a certain age range. "If you struggle with irritability, anxiety, sadness or loss of enjoyment at the time of the menopausal transition," the card reads, "please call us and help yourself while helping others."

The N.I.H., it turns out, has been quietly conducting mood and hormone studies for more than two decades under the direction of a psychiatrist named Peter Schmidt and his predecessor, David Rubinow, who is now chairman of the psychiatry department at the University of North Carolina. The research was first set into motion by Rubinow's postgraduate interest in premenstrual syndrome; the idea of giving younger women drugs to lower and flatten temporarily their estrogen and progesterone levels, essentially inducing menopause, was initially conceived to determine the role of hormones in PMS — to see whether these young women got relief when their hormones stopped the cresting and dropping of the normal menstrual cycle. (It often worked as a short-term treatment and yes, the young women often got hot flashes.) In recent years, the induced-menopause experiments have continued, among many other studies, as part of an effort to try to understand the chemistry of women like Julia Berry and me — women for whom perimenopause turns into what Berry described to me as "psychological misery, not myself and absent from the world."

Berry is 55, ponytailed and roundish and pretty. She was divorced a long time ago, raised three good kids mostly on her own and has a firm handshake and a job she loves. Her troubles started in her late 40s, in the standard way, with hot flashes and jerking awake at 3 a.m. and then escalated into something much fiercer.

Like me, at the worst of it, she occasionally found herself in traffic, wishing silently for an oncoming truck that might exit her swiftly from this life without qualifying as a suicide. A physician prescribed antidepressants. They helped, with both the anguish and the flashes, but not enough. "I am one of the most steady, even-keeled, hard to ruffle, really unflappable . . . truly," Berry told me. "I *am*. I, generally speaking, can be completely relied upon to do the sensible right thing almost all the time. Which is one of the reasons this period in my life has been so weird."

She called the N.I.H. number at once. She was quickly evaluated, enrolled in a double-blind study of the effects of estrogen on perimenopausal depression and sent home with a paper bag containing a mystery patch. When I asked Berry to describe the sensation of the next few weeks, she looked up at the ceiling for a second to think. "Kind of like having been in a smoky room, waving your arms and now seeing that the exhaust fan is taking a little at a time," she said. "My mood lifted. First time in three years I wasn't waking up at 3 in the morning. That's when I knew I wasn't on the placebo. It was very clear to me that there was something fundamentally wrong with my chemical systems, and that whatever was in this patch was setting things right, so that I could function like a regular human being — the human being I was familiar with."

What medicine doesn't know about the chemistry of mood, including clinical depression, dwarfs what medicine doesn't know about hormones. It would be handy for science if Berry and I could have made our heads available for dissection at certain points in recent years; as it is, we're able to answer as many elaborations on "I feel bad" or "I feel good" as researchers might wish to throw at us, but they still have no way of pinning down where we belong on the scale of menopausal distress, or what exactly we're doing there. We could be extra-high-volume versions of the women who are having an ordinary rough time of it, like Roberta Brinton — the women who hot-flash and can't sleep and cast about for vocabulary with which to describe feeling, as Brinton puts it, "just off." Or we could belong to some subcategory of anomalies, women with a wired-in susceptibility to depression — gene pools, childhoods, whatever — that was fired up by abrupt hormonal change.

Some psychological surveys will tell you there's no evidence for a surge of clinical depression at menopause. I believe that, given how many other phases of life can unhinge us, but I also believe — no, actually, I *know* — that there is a difficult thing that happens to some women in the perimenopausally affected brain. Hostile as I am to generalizations involving women rendered fragile by biology, here I am, and here, too, is Berry, both of us pulled out of something terrible by a pharmaceutical infusion of estrogen. Two physicians who specialize in hormones and mood, Louann Brizendine, a neuropsychiatrist at the University of California, San Francisco, and Claudio Soares, a Canadian research psychiatrist who works at McMaster University in Ontario, told me that women who seek them out tell variations of the same story Berry and I took to our doctors: I know that something is wrong with me because I also know, somewhere in the noncrazy part of myself, that there is such pleasure to be offered by the circumstances of my grown-up life.

"These women thought they were losing their minds," Brizendine told me, describing the 40-to-60-year-old patients she began seeing when she opened the Women's Mood and Hormone Clinic at the university in 1994. "In 1994 we didn't have words for it," she said. "Now we do. It's called perimenopausal depression."

Brizendine and Soares, like Schmidt and Rubinow, have found that various combinations work with varying degrees of effectiveness for many of us — hormones with an antidepressant, hormones without an antidepressant, sometimes antidepressants on their own. The alternatives-to-hormones recommendations are mostly fine things in their own right, varying from certainly useful to harmless: exercise regularly, keep the weight down, easy on the caffeine, calm yourself with deep breathing or yoga, try black cohosh. (You could start a bar brawl over the efficacy of black cohosh, but the general consensus seems to be: if it works for you, go for it.) But the troubles set off by ricocheting hormones are reliably fixed by making the hormones stop ricocheting. And the laborious weighing of hormones' benefits versus hormones' harms — maybe not at the crisis moment, for those of us at our most distraught, but later, one or two or five years down the road — is something still undertaken by millions of women along the full breadth of the perimenopausal spectrum.

How in the world to do it wisely enough so the calculation is as right for each of us as it can possibly be? JoAnn Manson's book contains the most careful checklist I've seen yet; by the time you answer all the personal-history questions the book asks you to consider, you've read 82 pages. Breast cancer is a factor, to be sure, but so are colorectal cancer, ovarian cancer, stroke, hip fracture and diabetes. If the timing hypothesis proves right and estrogen really does protect our brains and our hearts as long as we start it early enough, the calculation only grows that much more important and complex. There are moving pieces involved in working

out every one of these risks in relation to everything else, and anyone who thinks there's a bumper-sticker answer to the hormones question — don't take them, you're sure to be better off — is, like me that day in the psych unit, neither listening to scientific argument nor reading the fine print.

Here's one example from the many to which researchers have pointed me this winter. Remember MPA? The synthetic progesteronelike substance used along with equine estrogens in the W.H.I.? There was a second W.H.I. hormones-versus-placebo trial, of nearly 11,000 women, that was also started in the early 1990s, just like the one that was halted in 2002. All the women enrolled in this second study had undergone hysterectomies, which meant they had zero risk for uterine cancer. So the women on medications in this trial were taking only equine estrogens — no MPA, which you'll recall is given to protect the uterus. Their study was stopped in 2004, also before its planned end date, because the estrogen-taking women were showing a higher risk of stroke than the women on the placebo. But their breast-cancer rate was *lower*. The hormone-taking women with hysterectomies in that second study, who used estrogen without MPA, showed a 23 percent lower risk of invasive breast cancer than their counterparts who were taking no hormones at all.

Nobody's persuaded that this means MPA promotes breast cancer while estrogen does not. It's clear that estrogen acts aggressively on certain breast malignancies and that any woman who has had breast cancer or has a history of it in her immediate family should stay off estrogen. This is one of the principal reasons such intense work is under way right now, in labs like Roberta Brinton's, to develop estrogenic variants — molecular substances designed to latch only to certain receptors (in the brain, say, where the activated receptors can do their good works) while ignoring receptors in the breast and uterus. And there are plenty of confounding factors, as scientists say, with regard to the women in the no-MPA trial. They all had undergone hysterectomies, for one thing; maybe whatever caused them to require uterine removal in the first place affected their reactions to the estrogen.

Or it could have been a fluke. But the MPA wrinkle adds suspicion and urgency to the timing-hypothesis questions about what really goes on when women of our demographic use hormones, and Julia Berry and I spent a long time talking about this, the adding and subtracting, the guessing and weighing, the balancing of what we think we know about ourselves against what we cannot possibly foresee. We will both, for the present, continue wearing estrogen patches. Berry turned out to be right, of course; she wasn't on the placebo, which the N.I.H. doctors told her when she finished the study. And as she hurried to fill her own patch prescription, she found her gratitude mixed with more than a little frustration. "Why did my primary-care physician give me an antidepressant when I could have had something simple, like estrogen?" she asked. "Why don't they know?"

We talked about breast cancer, because that is the nightmare illness in nearly all our calculations, for most of us the visual closest to hand. Three of my best friends have endured the full breast-cancer horror show and by now have retired their wigs. All have survived. None had been on hormone replacement. This is information that batters me steadily but not helpfully, like my ex-smoker paternal aunt's fatal lung cancer and the fact that I'm a lifetime nonsmoker and regular exerciser with extremely good cholesterol levels. How do my lowered risks from one column balance against my question marks over in another column? What to do?

"I'd rather monitor something I know can go wrong than go on living in the state I was in," Berry said. "I could have my breasts removed. I like them. But they're not my life."

We've spent a fair bit of time by now, Julia Berry and I, shaking these uncertainties out and squinting at them. Do we wear these patches forever? We don't know. What happens when we do take them off, if we do? We don't know. Have we done nothing except delay a biological process, complete with hot flashes and another round of truck-crash fantasies, that at some point we'll have to bully our way through? We don't know, nor does any researcher I talked to this spring.

And there's this: Should luck and longevity cooperate, we are going to grow old. We're already old, by the standards of our children and our ancestors, but the generation to which we belong expects to live a rich messy life full of extremely loud rock music for another 30 years after menopause. Every midlife woman I know keeps redrawing for herself the defensible lines of intervention in the "natural" sequence of human aging. Obsessive multiple plastic surgeries are silly and desperate. Muscles kept in good working order are not. Where on that spectrum is a hormones-saturated pharmaceutical patch? What if the timing hypothesis is even partly right? Suppose all we learn about replacement estrogen, in the end, is that if it's started early enough it *might* protect the heart and the brain, and that its chemistry makes some of us feel more the way we did at 40 than the way our mothers did at 65? Not an elixir of youth. More like . . . reading glasses. Or

calcium supplements, or painkillers that stop the knee from hurting but carry risk warnings of their own. It has occurred to me that the better analogy might be a 13-year-old trying to ward off puberty by binding her breasts, but most of the time I don't think so, and if I do try stopping the patches, I know this to a certainty: I will keep a few extras in reserve, just in case.

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http://www.nytimes.com/2010/04/18/magazine/18estrogen-t.html?ref=magazine

Social Scientist Sees Bias Within

By JOHN TIERNEY

SAN ANTONIO — Some of the world's pre-eminent experts on bias discovered an unexpected form of it at their annual meeting. Discrimination is always high on the agenda at the Society for Personality and Social Psychology's conference, where psychologists discuss their research on racial prejudice, homophobia, sexism, stereotype threat and unconscious bias against minorities. But the most talked-about speech at this year's meeting, which ended Jan. 30, involved a new "outgroup."

It was identified by Jonathan Haidt, a social psychologist at the University of Virginia who studies the intuitive foundations of morality and ideology. He polled his audience at the San Antonio Convention Center, starting by asking how many considered themselves politically liberal. A sea of hands appeared, and Dr. Haidt estimated that liberals made up 80 percent of the 1,000 psychologists in the ballroom. When he asked for centrists and libertarians, he spotted fewer than three dozen hands. And then, when he asked for conservatives, he counted a grand total of three.

"This is a statistically impossible lack of diversity," Dr. Haidt concluded, noting polls showing that 40 percent of Americans are conservative and 20 percent are liberal. In his speech and in an interview, Dr. Haidt argued that social psychologists are a "tribal-moral community" united by "sacred values" that hinder research and damage their credibility — and blind them to the hostile climate they've created for non-liberals.

"Anywhere in the world that social psychologists see women or minorities underrepresented by a factor of two or three, our minds jump to discrimination as the explanation," said Dr. Haidt, who called himself a longtime liberal turned centrist. "But when we find out that conservatives are underrepresented among us by a factor of more than 100, suddenly everyone finds it quite easy to generate alternate explanations."

Dr. Haidt (pronounced *height)* told the audience that he had been corresponding with a couple of non-liberal graduate students in social psychology whose experiences reminded him of closeted gay students in the 1980s. He quoted — anonymously — from their e-mails describing how they hid their feelings when colleagues made political small talk and jokes predicated on the assumption that everyone was a liberal.

"I consider myself very middle-of-the-road politically: a social liberal but fiscal conservative. Nonetheless, I avoid the topic of politics around work," one student wrote. "Given what I've read of the literature, I am certain any research I conducted in political psychology would provide contrary findings and, therefore, go unpublished. Although I think I could make a substantial contribution to the knowledge base, and would be excited to do so, I will not."

The politics of the professoriate has been studied by the economists Christopher Cardiff and Daniel Klein and the sociologists Neil Gross and Solon Simmons. They've independently found that Democrats typically outnumber Republicans at elite universities by at least six to one among the general faculty, and by higher ratios in the humanities and social sciences. In a 2007 study of both elite and non-elite universities, Dr. Gross and Dr. Simmons reported that nearly 80 percent of psychology professors are Democrats, outnumbering Republicans by nearly 12 to 1.

The fields of psychology, sociology and anthropology have long attracted liberals, but they became more exclusive after the 1960s, according to Dr. Haidt. "The fight for civil rights and against racism became the sacred cause unifying the left throughout American society, and within the academy," he said, arguing that this shared morality both "binds and blinds."

"If a group circles around sacred values, they will evolve into a tribal-moral community," he said. "They'll embrace science whenever it supports their sacred values, but they'll ditch it or distort it as soon as it threatens a sacred value." It's easy for social scientists to observe this process in other communities, like the fundamentalist Christians who embrace "intelligent design" while rejecting Darwinism. But academics can be

selective, too, as Daniel Patrick Moynihan found in 1965 when he warned about the rise of unmarried parenthood and welfare dependency among blacks — violating the taboo against criticizing victims of racism. "Moynihan was shunned by many of his colleagues at Harvard as racist," Dr. Haidt said. "Open-minded inquiry into the problems of the black family was shut down for decades, precisely the decades in which it was most urgently needed. Only in the last few years have liberal sociologists begun to acknowledge that Moynihan was right all along."

Similarly, Larry Summers, then president of Harvard, was ostracized in 2005 for wondering publicly whether the preponderance of male professors in some top math and science departments might be due partly to the larger variance in I.Q. scores among men (meaning there are more men at the very high and very low ends). "This was not a permissible hypothesis," Dr. Haidt said. "It blamed the victims rather than the powerful. The outrage ultimately led to his resignation. We psychologists should have been outraged by the outrage. We should have defended his right to think freely."

Instead, the taboo against discussing sex differences was reinforced, so universities and the National Science Foundation went on spending tens of millions of dollars on research and programs based on the assumption that female scientists faced discrimination and various forms of unconscious bias. But that assumption has been repeatedly contradicted, most recently in a study published Monday in The Proceedings of the National Academy of Sciences by two Cornell psychologists, Stephen J. Ceci and Wendy M. Williams. After reviewing two decades of research, they report that a woman in academic science typically fares as well as, if not better than, a comparable man when it comes to being interviewed, hired, promoted, financed and published.

"Thus," they conclude, "the ongoing focus on sex discrimination in reviewing, interviewing and hiring represents costly, misplaced effort. Society is engaged in the present in solving problems of the past." Instead of presuming discrimination in science or expecting the sexes to show equal interest in every discipline, the Cornell researchers say, universities should make it easier for women in any field to combine scholarship with family responsibilities.

Can social scientists open up to outsiders' ideas? Dr. Haidt was optimistic enough to title his speech "The Bright Future of Post-Partisan Social Psychology," urging his colleagues to focus on shared science rather than shared moral values. To overcome taboos, he advised them to subscribe to National Review and to read Thomas Sowell's "A Conflict of Visions."

For a tribal-moral community, the social psychologists in Dr. Haidt's audience seemed refreshingly receptive to his argument. Some said he overstated how liberal the field is, but many agreed it should welcome more ideological diversity. A few even endorsed his call for a new affirmative-action goal: a membership that's 10 percent conservative by 2020. The society's executive committee didn't endorse Dr. Haidt's numerical goal, but it did vote to put a statement on the group's home page welcoming psychologists with "diverse perspectives." It also made a change on the "Diversity Initiatives" page — a two-letter correction of what it called a grammatical glitch, although others might see it as more of a Freudian slip.

In the old version, the society announced that special funds to pay for travel to the annual meeting were available to students belonging to "underrepresented groups (i.e., ethnic or racial minorities, first-generation college students, individuals with a physical disability, and/or lesbian, gay, bisexual, or transgendered students)."

As Dr. Haidt noted in his speech, the "i.e." implied that this was the exclusive, sacred list of "underrepresented groups." The society took his suggestion to substitute "e.g." — a change that leaves it open to other groups, too. Maybe, someday, even to conservatives.

http://www.nytimes.com/2011/02/08/science/08tier.html?src=me&ref=general

Downtown Skyscraper for the Digital Age

By NICOLAI OUROUSSOFF

Fred R. Conrad/The New York Times
8 Spruce Street. the tallest luxury residential tower in New York City, was designed by the architect Frank Gehry

Many New Yorkers have been following the construction of the new residential tower at 8 Spruce Street, just south of City Hall, with a mix of awe and trepidation.

Frank Gehry, the building's architect, has had a rough time in this city. His first commission here, years ago, was for an Upper East Side town house that was never built; his client, an oil heiress, fired him over Champagne and strawberries. A more recent foray, the massive Atlantic Yards development in Brooklyn, drew the ire of local activists, who depicted him as an aging liberal in bed with the devil — a New York City real estate developer.

The Spruce Street project (formerly called Beekman Tower) would not only be Mr. Gehry's first skyscraper, but it was also being built for the same developer, Bruce Ratner. And as the tallest luxury residential tower in the city's history, it seemed to epitomize the skyline's transformation from a symbol of American commerce to a display of individual wealth.

Only now, as the building nears completion, is it possible to appreciate what Mr. Gehry has accomplished: the finest skyscraper to rise in New York since Eero Saarinen's CBS building went up 46 years ago. And like that tower, and Philip Johnson's AT&T (now Sony) building after it, 8 Spruce Street seems to crystallize a particular moment in cultural history, in this case the turning point from the modern to the digital age.

The tower, 76 stories high and clad in a rumpled stainless-steel skin, stands at the northern edge of the financial district on a tight lot hemmed in by one-way streets. The Pace University building, a wide, Brutalist-style structure completed in 1970, cuts it off from the rest of the city to the north; just beyond are the spaghettilike access ramps of the Brooklyn Bridge. To the east, across City Hall Park, are two early landmarks of skyscraper design, Cass Gilbert's 1913 Woolworth building and McKim, Mead & White's 1912 Municipal building.

Mr. Gehry's design is least successful at the bottom, where he was forced to plant his tower on top of a six-story base that will house a new public grammar school and one floor of hospital services — an odd coupling of private and public interests that was a result of political horse trading rather than any obvious benefit that would be gained from so close a relationship between the two.

The school is clad in conventional orange brick, with heavy steel frame windows that give it the look of a converted factory. Its main facade, with a glass-fronted lobby facing William Street to the east, is relatively

straightforward, but it's a letdown after you've seen the gorgeously wrought exterior of the tower above. (Mr. Gehry did not design the interiors of the school, which is still under construction, and students may ask why the pampered young professionals living above them get to live in apartments designed by an architectural superstar while they will have to make do with a no-name talent.)

Not surprisingly, the two groups won't be mixing. Residents will enter through a covered drive that cuts through the block along the building's western side. Framed by massive brick pillars and a glass-enclosed lobby, the space's generous proportions will accommodate taxis and limousines ferrying people in and out of the building, making it feel more like a luxury hotel than a classic Manhattan apartment building.

None of this matters much, however, once you see the tower in the skyline, a view that seems to lift Lower Manhattan out of its decade-long gloom. The building is particularly mesmerizing from the Brooklyn waterfront, where it's possible to make out one of the deep setbacks that give the building its reassuringly old-fashioned feel. In daylight the furrowed surfaces of the facades look as if they've been etched by rivulets of water, an effect that is all the more dramatic next to the clunky 1980s glass towers just to the south. Closer up, from City Hall Park, the same ripples look softer, like crumpled fabric.

(The flat south facade is comparatively conventional, and some may find perverse enjoyment in the fact that the building presents its backside to Wall Street.)

The power of the design only deepens when it is looked at in relation to Gilbert's Woolworth building. A steel frame building clad in neo-Gothic terra-cotta panels, Gilbert's masterpiece is a triumphant marriage between the technological innovations that gave rise to the skyscraper and the handcrafted ethos of an earlier era.

Mr. Gehry's design is about bringing that same sensibility — the focus on refined textures, the cultivation of a sense that something has been shaped by a human hand — to the digital age. The building's exterior is made up of 10,500 individual steel panels, almost all of them different shapes, so that as you move around it, its shape is constantly changing. And by using the same kind of computer modeling that he used for his Guggenheim Museum in Bilbao, Spain, more than a decade ago, he was able to achieve this quality at a close to negligible increase in cost.

But Mr. Gehry is also making a statement. The building's endlessly shifting surfaces are an attack against the kind of corporate standardization so evident in the buildings to the south and the conformity that it embodied. He aims, as he has throughout his career, to replace the anonymity of the assembly line with an architecture that can convey the infinite variety of urban life. The computer, in his mind, is just a tool for reasserting that variety.

That mission is expressed inside the building as well. Mr. Gehry has sometimes been criticized for creating wildly sculptural forms that are nothing more than masks: elaborate wrappers draped over conventional interiors. Here the ripples that run up and down the facades form angular window bays inside, creating pockets of space that give the apartments an unusually intimate feel. They also provide dramatically angled views of the surrounding skyline. (Some apartments will even get occasional, unexpected views between neighboring apartments, a side effect that could be good or a bad depending on how many exhibitionists live there.)

But in some ways it is the building's relation to yet another landmark — the twin towers — that makes 8 Spruce Street so stirring. Mr. Gehry won the commission to design his building sometime in late 2003, just as the competition to redesign ground zero was heating up. The battles that ensued over that site's master plan seemed to reflect America at its worst: a volatile mix of government ineptitude, commercial greed and jingoism. Its main emblem, the building formerly called the Freedom Tower, which is only taking shape today, remains an emblem of national hubris that is hollow at its core.

Mr. Gehry's building, by contrast, doesn't try to dominate the skyline. Its aims (beyond the obvious commercial ones) are comparatively modest: to celebrate the joy that can come out of creative freedom and, by extension, to reassert the individual's place within a larger social framework. His interest lies in the clashing voices that give cities their meaning; it is democratic at heart.

http://www.nytimes.com/2011/02/10/arts/design/10beekman.html?ref=arts

A Building Forms a Bridge Between a University's Past and Future

By NICOLAI OUROUSSOFF

Robert Caplin for The New York Times
Northwest Corner Building Designed by José Rafael Moneo, Columbia University's new addition is anticipated as a gateway to a campus planned for West Harlem

I'm sure that a few preservationists are already grumbling about the new interdisciplinary science building at Columbia University. It certainly doesn't fade politely into its brick surroundings. But they'd be wrong to think that it disrespects history.

Designed by the Spanish architect José Rafael Moneo, the new building, at the corner of Broadway and 120th Street, draws on a range of precedents, from the austere Modernism of Adolf Loos to the original McKim, Mead & White master plan for Columbia's Morningside Heights campus. Its muscular steel-and-aluminum frame is a vivid example of how to fit into a difficult historical context without slavishly kowtowing to it.

It is also, not incidentally, a work of healing. Seen in the context of Columbia's often tense relationship with its Harlem neighbors, including recent battles over its plans to build a new 17-acre campus in West Harlem, the building is a gleaming physical expression of the university's desire to bridge the divide between the insular world of the campus and the community beyond its walls.

Mr. Moneo is well suited to this task. A former chairman of Harvard University's Graduate School of Design, he has a modest, thoughtful demeanor. (Colleagues and students often describe him as a priestlike figure.) His best works — like the National Museum of Roman Art in Mérida, Spain, and an expansion of the 19th-century Atocha railway station in Madrid — are part of a continuing dialogue with his historical predecessors. Like these earlier projects, the science building, officially the Northwest Corner Building, serves as a hinge between past and present. Framed to the east and south by the austere 1920s-era masonry buildings of the McKim, Mead & White campus, it will eventually serve as the main gateway between that campus and the West Harlem one, which will be located several blocks away to the northwest.

Mr. Moneo's design is carefully grounded in the original campus plan. The building's base, which is made of the same rose-colored granite as the buildings that flank it, is conceived as an extension of the existing street wall. Its 14-story height, considerably greater than that of its neighbors, echoes the brick and limestone gothic tower of the Union Theological Seminary, which stands cater-corner across the street. (It is also slightly lower than the tower that McKim, Mead & White originally proposed for the site.)

But it is the tension Mr. Moneo creates between new and old that brings the building to life. The upper floors are clad in what may be the most elegant aluminum siding in America: a taut steel grid filled in with an irregular pattern of diagonal steel braces and aluminum louvers. The braces are not decorative — they reflect the uneven loads and stresses on the building, which is supported on an enormous truss that spans the gym below. But even if you don't know this, you intuitively sense the tension that is built into them; it is as if the structure were straining to break free of the constraints of the site.

The effect is especially acute at the corner, where the building suddenly seems to crack open from the stress, its upper floors cantilevering 15 feet over the lobby entrance. The lobby interior is clad in richly veined Portuguese marble, the kind of sumptuous material that Loos used to lessen the severity of his spaces. A stair, in the same marble, ascends to a mezzanine-level cafe that overlooks the street through floor-to-ceiling windows: a kind of interstitial zone floating just above the city. From there, more stairs lead up to a campus-level lobby, 35 feet above the street. (All these spaces are open to the public.)

This is superb architecture: clean, compact and perfectly calibrated. And the sequence is even more powerful in reverse: from the campus-level lobby, the climb down the staircase is something like descending into a marble quarry.

But the design is also a means of reinforcing the university's public mission. By easing you through the transition from one level to the other in just three quick turns along the stair, Mr. Moneo has fused together two disparate worlds — the campus and the street outside — and created places of intense social communion. (A wide exterior staircase, located on the east side of the building, makes this connection even more directly, allowing people to bypass the structure in moving between the campus and 120th Street.)

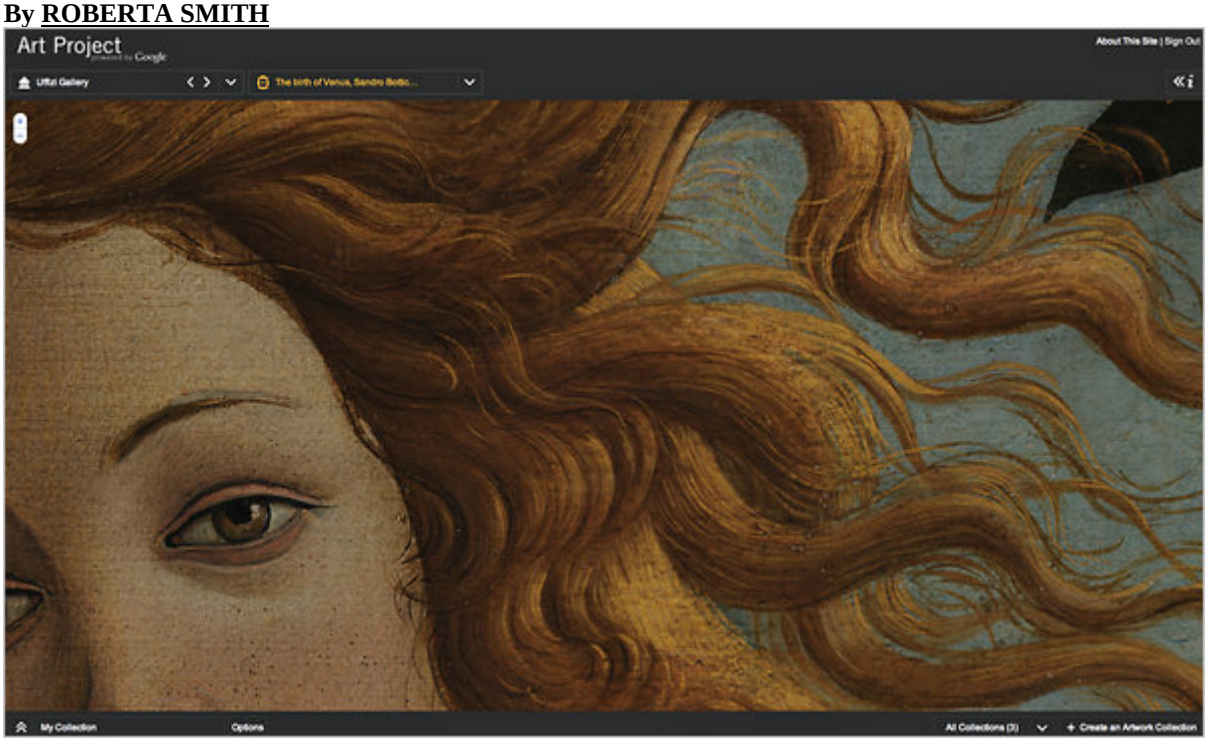
And a similar spirit of openness and exchange exists on the upper floors, whose big, loftlike spaces were designed so that they could be reconfigured to fit the needs of various researchers. The seventh floor, for example, which houses molecular and nanotechnology laboratories, is a maze of private offices, while the 12th-floor chemistry labs are more open and airy. Enclosed bridges connect these floors to neighboring science buildings as a way to encourage the kind of interdisciplinary exchange that is the building's core mission.

In short, this is a building conceived in opposition to our contemporary culture, with its constant visual noise and unforgiving pace. Mr. Moneo aims to lift us, if only momentarily, out of our increasingly frenetic lives — to slow us down and force us to look at the world around us, and at one another, more closely. It's a big, tough building, but it's tenderhearted too.

http://www.nytimes.com/2011/02/09/arts/design/09moneo.html?ref=design

The Work of Art in the Age of Google

By ROBERTA SMITH



Uffizi Museum/Google Art Project
On Art Project, you can look closely at the details of works like Botticelli's "Birth of Venus.

If art is among your full-blown obsessions or just a budding interest, Google, which has already altered the collective universe in so many ways, changed your life last week. It unveiled its Art Project, a Web endeavor that offers easy, if not yet seamless, access to some of the art treasures and interiors of 17 museums in the United States and Europe.

It is very much a work in progress, full of bugs and information gaps, and sometimes blurry, careering virtual tours. But it is already a mesmerizing, world-expanding tool for self-education. You can spend hours exploring it, examining paintings from far off and close up, poking around some of the world's great museums all by your lonesome. I have, and my advice is: Expect mood swings. This adventure is not without frustrations.

On the virtual tour of the Uffizi in Florence the paintings are sometimes little more than framed smudges on the wall. (The Dürer room: don't go there.) But you can look at Botticelli's "Birth of Venus" almost inch by inch. It's nothing like standing before the real, breathing thing. What you see is a very good reproduction that offers the option to pore over the surface with an adjustable magnifying rectangle. This feels like an eerie approximation, at a clinical, digital remove, of the kind of intimacy usually granted only to the artist and his assistants, or conservators and preparators.

There are high-resolution images of more than 1,000 artworks in the Art Project (googleartproject.com) and virtual tours of several hundred galleries and other spaces inside the 17 participating institutions. In addition each museum has selected a single, usually canonical work — like the Botticelli "Venus" — for star treatment. These works have been painstakingly photographed for super-high, mega-pixel resolution. (Although often, to my eye, the high-resolution version seems as good as the mega-pixel one.)

The Museum of Modern Art selected van Gogh's "Starry Night," and you can see not only the individual colors in each stroke, but also how much of the canvas he left bare. The Metropolitan Museum of Art's star painting is Bruegel's "Harvesters," with its sloping slab of yellow wheat and peasants lunching in the

foreground. Deep in the background is a group of women skinny-dipping in a pond that I had never noticed before.

In the case of van Gogh's famous "Bedroom," the star painting chosen by the Van Gogh Museum in Amsterdam, I was able to scrutinize the five framed artworks depicted on the chamber's walls: two portraits, one still life and two works, possibly on paper, that are so cursory they look like contemporary abstractions. And I was enthralled by the clarity of the star painting of the National Gallery in London, Hans Holbein's "Ambassadors," and especially by the wonderful pile of scientific instruments — globes, sun dials, books — that occupy the imposing two-tiered stand flanked by the two young gentlemen.

Google maintains that, beyond details you may not have noticed before, you can see things not normally visible to the human eye. And it is probably true. I could make out Bruegel's distant bathers when I visited the Met for a comparison viewing, but not the buttocks of one skinny-dipper, visible above the waves using the Google zoom. Still, the most unusual aspects of the experience are time, quiet and stasis: you can look from a seated position in the comfort of your own home or office cubicle, for as long as you want, without being jostled or blocked by other art lovers.

At the same time the chance to look closely at paintings, especially, as *made* things, really to study the way artists construct an image on a flat surface, is amazing, and great practice for looking at actual works. And while the Internet makes so much in our world more immediate, it is still surprising to see what it can accomplish with the subtle physicality of painting, whether it is the nervous, fractured, tilting brush strokes of Cezanne's "Château Noir" from 1903-4, at the Museum of Modern Art, or the tiny pelletlike dots that make up most of Chris Ofili's "No Woman No Cry" from about a century later at the Tate Modern in London (the only postwar work among the 17 mega-pixel stars).

The Ofili surface also involves collaged images of Stephen Lawrence, whose 1993 murder in London became a turning point in Britain's racial politics; along with scatterings of glitter that read like minuscule, oddly cubic bits of gold and silver; and three of those endlessly fussed-over clumps of elephant dung, carefully shellacked and in two cases beaded with the word No. Take a good look and see how benign they really are. (You can also see the painting glow in the dark, revealing the lines "R.I.P./Stephen Lawrence/1974-1993.")

Another innovation of the Art Project is Google's adaptation of its Street View program for indoor use. This makes it possible, for example, to navigate through several of the spacious salons at Versailles gazing at ceiling murals — thanks to the 360-degree navigation — or to get a sharper, more immediate sense than any guidebook can provide of the light, layout and ambience of the Tretyakov Gallery in Moscow. It also means that if your skill set is shaky, you can suddenly be 86'ed from the museum onto the street, as I was several times while exploring the National Gallery.

Keep in mind that usually only a few of the many, many works encountered on a virtual tour are available for high-res or super-high-res viewing. And those few aren't always seen in situ, hanging in a gallery. The architectural mise-en-scène is the main event of the virtual tours in most cases, from the Uffizi's long, grand hallways to the gift shop of the Rijksmuseum in Amsterdam and the modest galleries of the Kampa Museum in Prague, where the star paintings is Frantisek Kupka's 1912-13 "Cathedral," the only abstraction among what could be called the Google 17.

The Art Project has been hailed as a great leap forward in terms of the online art experience, which seems debatable, since most museums have spent at least the last decade — and quite a bit of money — developing Web access to works in their collections. On the site of the National Gallery, for example, you can examine the lush surface of Velázquez's "Rokeby Venus" with a zoom similar to the Art Project's. Still, Google offers a distinct and extraordinary benefit in its United Nations-like gathering of different collections under one technological umbrella, enabling easy online travel among them.

When you view a work by one artist at one museum, clicking on the link "More works by this artist" will produce a list of all the others in the Art Project system. But some fine-tuning is needed here. Sometimes the link is missing, and sometimes it links only to other works in that museum. Other tweaks to consider: including the dates of the works on all pull-down lists, and providing measurements in inches as well as centimeters.

Despite the roster of world-class museums, there are notable omissions: titans like the Louvre and the Musée d'Orsay in Paris, the Prado in Madrid and the Kunsthistorisches Museum in Vienna, not to mention most major American museums, starting with the National Gallery in Washington. Without specifying who turned

it down, Google says that many museums were approached, that 17 signed on, and that it hopes to add more as the project develops.

This implies an understandable wait-and-see attitude from many institutions, including some of the participants. The Museum of Modern Art, for example, has made only one large gallery available — the large room of French Post-Impressionist works that kicks off its permanent collection displays — along with 17 paintings that are all, again, examples of 19th-century Post-Impressionism. (Oh, and you can wander around the lobby.)

On first glance this seems both unmodern in focus and a tad miserly, given that several museums offer more than 100 works and at least 15 galleries. But MoMA is being pragmatic. According to Kim Mitchell, the museum's chief communications officer , the 17 paintings "are among the few in our collection that do not raise the copyright-related issues that affect so many works of modern and contemporary art." In other words, if and when the Art Project is a clear success, the Modern will decide if it wants to spend the time and money to secure permission for Picasso's "Demoiselles d'Avignon" and the like to appear on it.

This might also hold true for the Museo Reina Sofia in Madrid, which owns Picasso's "Guernica," but has so far limited its participation primarily to 13 paintings by the Cubist Juan Gris and 35 photographs from the Spanish Civil War. Needless to say, the works and galleries that each museum has selected for the first round of the Art Project makes for some interesting institutional psychoanalysis.

From where I sit Google's Art Project looks like a bandwagon everyone should jump on. It makes visual knowledge more accessible, which benefits us all.

In many ways this new Google venture is simply the latest phase of simulation that began with the invention of photography, which is when artworks first acquired second lives as images and in a sense, started going viral. These earlier iterations — while never more than the next best thing — have been providing pleasure for more than a century through art books, as postcards, posters and art-history-lecture slides. For all that time they have been the next best thing to being there. Now the next best thing has become better, even if it will never be more than next best.

http://www.nytimes.com/2011/02/07/arts/design/07google.html?ref=design

It's Not Candid Camera, It's Random Culture

By CAROL KINO

Knight Foundation

Dennis Scholl directs the Knight Arts Program, which sponsors the Random Acts of Culture events in eight cities.

PHILADELPHIA — It was just another winter Saturday morning at the Reading Terminal Market, an expansive food hall at the heart of this city's downtown. Toward noon people began flocking to the restaurants in the central court, creating such a din that nobody seemed to pay much mind when the sound of recorded music floated through the air.

Suddenly a man standing in line at a cheese steak stand raised his arm with a flourish and turned to the crowd. "Votre toast, je peux vous le rendre" he sang in a thrilling baritone. Before anyone could figure out what was happening — that he had launched into the "Toreador Song" from Bizet's "Carmen" — another man leaped onto a table across the court and took up the second verse. He was joined by a third man, who had seemingly wandered in from the crowd.

And soon more than 30 members of the Opera Company of Philadelphia chorus were singing, dancing and toasting one another with coffee and soda cups, as the soloists turned the cheese steak stand into an impromptu opera stage. Around them people laughed and cried in wonderment, many of them whipping out their phones and cameras to preserve the moment.

As the music ended four people in the crowd held up signs reading, "You have just experienced a Random Act of Culture."

Since October more than 160 such pop-up events have taken place in eight cities around the country. In Akron, Ohio; Charlotte, N.C.; Detroit; Macon, Ga.; Miami; St. Paul; and San Jose, Calif., as well as here, anyone who's happened into the right mall, market or municipal building at the right time has been jolted from the daily grind by an eclectic range of performances, from arias and string quartets to tangos and poetry readings. The project is the first major initiative undertaken by the Knight Arts Program, begun last March by the John S. and James L. Knight Foundation.

"Everything we do revolves around the idea of weaving the arts into the fabric of the community," said Dennis Scholl, the arts program's director, who aims to produce 1,000 Random Acts by the end of 2013. "Our hypothesis is that people care about the arts, and if you analyze where they are and bring art to them, they will be passionate about it."

But he added that, in contrast to most flash mob performances, "we're taking incredibly talented professionals and putting them into the streets."

The passion he speculated about is evident on YouTube, where professionally shot videos of Random Act events have become something of an Internet sensation. The biggest hit by far has been the Oct. 30 performance of Handel's "Hallelujah" chorus, also organized by the Philadelphia opera, for which more than 650 singers burst into song in the Grand Court of Macy's Center City accompanied by the store's legendary organ. The clip now has over seven million views and has inspired countless other "Hallelujah" flash performances around the world.

"That's the beauty of the Web," Mr. Scholl said. "You can create a sense of community that isn't geographic."

Founded in 1950 by the scions of the Knight newspaper chain, the Knight Foundation is probably best known for financing digital innovation in journalism. Yet its overarching mission is "to create informed and engaged communities" in the 26 cities where the company had newspapers in 1991, the year James L. Knight died, focusing primarily on the eight "Random Acts" towns, where Knight maintains individual program offices.

The seeds for the arts program were already germinating in 2007, when the foundation's president, Alberto Ibargüen, embarked on a three-year survey, known as "Soul of the Community," with Gallup to ascertain how people become attached to their locales. What he learned, Mr. Ibargüen said, radically countered his preconceptions.

Especially after the 2008 recession, "I would have expected jobs to be the No. 1 reason people were attached to place," he said, "or political or civic engagement." Instead the top three factors turned out to be how many opportunities a community offers for socializing, its openness to different types of people and its aesthetic surroundings. Knight is always on the lookout for ways to "bring people together to share experience," Mr. Ibargüen said, and the survey "supported our notion" that the arts were a good way to do it.

To head the program, which disbursed over $15 million worth of grants last year, he tapped Mr. Scholl, the director of the Miami community program. A contemporary-art collector, Mr. Scholl has a long history as a visual arts patron. And he was already overseeing the Knight Arts Challenge, which since 2008 has invited people in Miami to suggest projects they'd like to realize, and has financed the winning ideas.

Although Knight previously supported cultural projects, the approach Mr. Scholl has taken with the new program is "to look at our grants through the lens of community engagement," he said, "and to look for ways to use technology and social media." In addition, each of the eight cities serves as a laboratory to develop pilot projects that can be spread to the others.

Last year, for example, Mr. Scholl expanded the Knight Arts Challenge to Philadelphia. (Winners will be announced in March.) Another project involves helping museums in Akron, Charlotte and Miami put portions of their holdings online. A third, whose location will be announced in March, will let people buy shares in local artists' work: the cultural equivalent of a farm share program. "Instead of a box of vegetables," said Mr. Scholl, "they'll get a box of editioned artworks."

Then, of course, there's Random Acts. Mr. Scholl conceived the idea early last year, after someone sent him a link to a YouTube video of a pop-up opera performance in the Central Market of Valencia, Spain. (At the end someone holds up a sign that reads, "Ves como te gusta la ópera?" — "See how you like opera?")

Although that video was actually part of a guerilla marketing campaign, Mr. Scholl saw in it the makings of a broader cultural experiment. As he put it, "What would happen if we brought the arts to people where they are en masse?"

He decided to try out "a beta performance" with a string quartet in the Miami-Dade County government center in May. As soon as the music began, "the crowd just gathered and gathered, and they went wild," he recalled. "So we knew we had something." He had already decided to finance 1,000 Random Acts when he realized that the Opera Company of Philadelphia was already doing its own pop-up performances, prompted by the same video from Valencia.

David B. Devan, the executive director of the company, said the link came his way when the company was trying to figure out "how we communicate the joy of singing to people who never go to the opera." So on April 24 the opera mounted its first pop-up performance at Reading Terminal Market, a 35-singer rendition of "Brindisi," the drinking song from Verdi's "Traviata," which they were about to open. The reaction was so positive, with a flurry of donations and many excited e-mails (not to mention more than 3.4 million YouTube views so far) that the company decided to try something bigger: putting on Handel's "Hallelujah" at Macy's. "We were trying to figure out how to pay for it," Mr. Devan said, "when the phone rang and it was Dennis, saying, 'We want to partner with you.' "

Knight's support allowed the "Hallelujah" performance to escalate wildly, eventually involving 28 groups — "everything from the Presbyterian church choir to the Gay Men's Chorus," Mr. Devan said. The opera now has a $30,000 Knight Foundation grant to create more collaborative performances with other groups here.

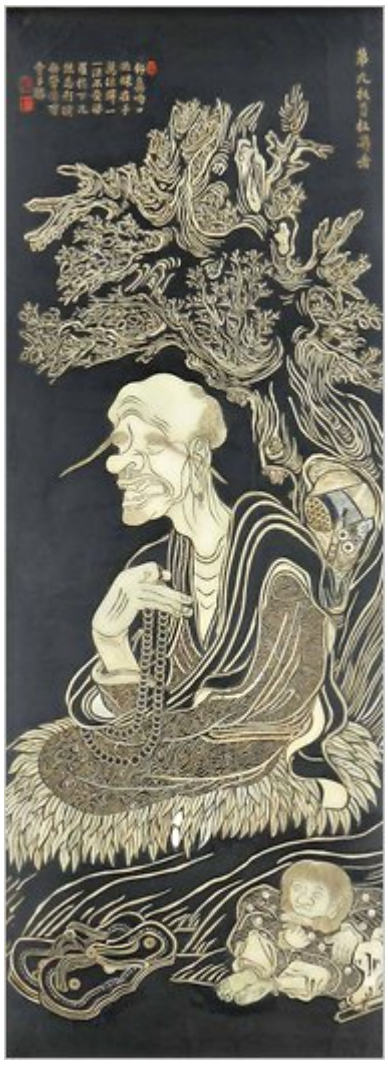
Not only have contributions risen, Mr. Devan said, but the Random Acts projects have transformed the company into an important player in the community.

Before, "if we had told the city's marketing people that we wanted to help rebrand Philadelphia, they'd have laughed," Mr. Devan said. "But now they're calling us. And it's not just good for the opera, it's good for all the other arts as well."

http://www.nytimes.com/2011/02/06/arts/design/06random.html?ref=design

A Man of Contradictions, With a Collection to Match

By HOLLAND COTTER



Palace Museum, Beijing
One section of a 16-panel screen, both garish and delicate, depicting early disciples of the Buddha, that is in "The Emperor's Private Paradise" at the Metropolitan Museum

When China's last emperor finally left the premises in 1924, the Forbidden City was renamed the Palace Museum, and a labyrinthine complex of ceremonial and domestic spaces, off limits to all but a few for centuries, was suddenly open to the world.
Still, it kept some secrets. Few visitors, for example, knew of the existence of a self-contained suite of small pavilions and gardens tucked away at the Forbidden City's northeast corner, echoing its shape.
They made up the Tranquillity and Longevity Palace, which, in the mid-18th century, had been remodeled as a potential retirement home by the adamantly unretiring and design-obsessed Qing dynasty emperor Qianlong.
He lavished attention on the palace — covered its walls with trompe l'oeil paintings, fitted it out with false doors, see-through partitions, Buddhist shrines and clocks — to make it a place that reflected his adventurous

tastes, a place where he might want to live. But in the end, he spent little time there. And the palace, often referred to now as the Qianlong Garden, had only a handful of imperial tenants after he died in 1799.
For most of the 20th century it stayed empty. The Chinese government had no cash to spare for its upkeep, and conserving Qing culture was on no one's list of priorities. The building exteriors were maintained, but the interiors, with their frozen-in-time ensembles of furniture, painting, textiles and luxury objects, were left to fend for themselves.
Things have changed. China, now (and not for the first time) a global power in need of an agreeable self-image to sell, has seen the wisdom of preserving its visual heritage — all of it. And international scholars of that heritage, once separated by distance, are now thoroughly networked. A concrete result of this new one-worldism is a collaboration, now in progress, between the Palace Museum and the World Monuments Fund to restore the Qianlong Garden to its former splendor.
Among the art historians acting as consultants to the project is Nancy Berliner, the curator of Chinese art at the Peabody Essex Museum in Salem, Mass. By 2003, the year the restoration got under way, Ms. Berliner had already scored a Qing-related coup of her own by overseeing the transfer, from China to the Salem museum, of an intact house dating to the dynasty. And last fall she scored a second one with "The Emperor's Private Paradise: Treasures From the Forbidden City," an exhibition she organized for the Peabody Essex, and which now appears, in a different form, at the Metropolitan Museum of Art.
The show is made up primarily of freshly conserved Qing objects — thrones, cabinets, screens, religious sculptures, paintings — from the collection of the Palace Museum, many specifically from Qianlong Garden buildings. Qianlong himself probably commissioned some of the items. Certainly his sensibility is written all over them.
Born in Beijing in 1711, Qianlong (pronounced Chee-en lohng) descended from non-Chinese-speaking northerners who called themselves Manchu and ruled China as the Qing dynasty from 1644 to 1911. Self-confident and adventurous, he was a ceaseless mover and doer, constantly making inspection tours of a country that during his reign was the largest and richest in the world.
Largeness, in fact, was his calling card. His cultural initiatives seem conceived precisely to generate preposterous statistics. He commissioned and participated in the creation of an anthology of 2,000 years of Chinese literature: it appeared in the form of 36,000 handwritten volumes, which he ordered to be copied several times.
A writer himself, he left more than 40,000 poems behind when he died. When he was 50, he published a compendium of his calligraphy. He acquired art of all kinds in record-breaking quantities. At one point he cataloged a collection of some 10,000 of his paintings, then went on to collect more.
He was a knot of contradictions. He preserved thousand of books in his anthology, but also destroyed thousands, some of them legendary classics, that he considered politically subversive. As an art connoisseur, he had an uncannily sensitive eye, yet he insisted on incising his name into precious ceramics and writing it repeatedly on priceless paintings, effectively defacing them.
Although he had many self-portraits made, no cohesive reading of his personality can be drawn from them. In one painting he is an imposing Confucian ancestor figure; in another, a humble young Daoist scholar. In a third piece we find him floating at the center of a Tibetan Buddhist mandala as the embodiment of the bodhisattva of wisdom, which he believed himself to be.
As a highly self-aware performer, he exploited the public relations uses of shape-shifting, offering alternate versions of himself to different audiences, Manchu, Han Chinese and European.
He was wary of Europe politically, but entranced by vision-tickling aspects of its art, like vanishing-point perspective and trompe l'oeil realism. Christianity left him cold — why should he worship a supreme being when he was one? — but he treasured Jesuit missionary artists like Giuseppe Castiglione and kept them on his payroll.
Contradiction is also the animating dynamic of the art in the Met show created to adorn the various buildings — reception halls, studios, libraries, Buddhist shrines — in the Qianlong Garden.
In the circular portrait of the young Qianlong in scholar robes in the first gallery, the pictorial space is pancake-flat, depthless. But in a Western-style mural painting on silk nearby, life-size figures of woman and child beckon us into a three-dimensional hall. (Several such murals cover walls in the one Qianlong Garden building that was fully restored in 2008 and can be digitally toured in another Met gallery.)

Realism in Qing art, however, often veers into the surreal, as is evident in a mesmerizingly bizarre furniture ensemble. Like some version of rustic Victoriana, all three units — chair, couch bed, foot stool — appear to be woven from roots and vines, though in this case the interwoven strands look freakishly alive, writhing and twisting like nests of snakes. Only when you inspect the furniture closely do you see that this organicism run riot is strictly an illusion. The roots and vines have been painstakingly puzzled together from many small pieces of wood, in a design meant to evoke a Daoist immersion in nature.

This kind of interplay between opposites — the unnatural and the natural, the grotesque and the spiritual — powers the show. Qianlong went for art and design that pushed such contrasts to the limit and beyond, short-circuiting received notions of good taste and bad taste to deliver little shocks of pleasure.

You can feel such zaps radiating from one work in particular: a 16-panel wood-and-lacquer screen carrying portraits of early disciples of the Buddha, known as luohans. These figures are traditionally pretty gross: ragged and repellent old men, with cartoon faces and hair sprouting from unlikely places. They're shown that way here too, but in a medium — white jade inlaid on black lacquer — that is so ethereal, and worked with such fineness, as to all but cancel out any impression of ugliness.

The screen holds another surprise too. When conservators moved it from its original position against a wall, they found that the reverse sides of the panels were painted with images of trees and flowers in tones of gold. Stunning!

At the Peabody Essex, the screen was free-standing and could be viewed from both sides. The Met, by contrast, has placed it in a long wall case, with the luohans face out, and a few panels flipped to give a sampling of the painting. And this is just one of the ways in which the Met edition of the show differs from the Salem original.

Judging from photographs, you can see that the installation Ms. Berliner devised at the Peabody Essex was spaciously laid out, with an effort made to simulate the architectural interior in which the objects were once found. At the Met, the same objects have been squeezed into the narrow Chinese painting galleries, with almost everything confined to tall cases designed to hold scrolls.

As if to compensate for a more straightened and prosaic approach, the New York presentation — organized by Maxwell K. Hearn, curator of Chinese art, with an ingenious design by Daniel Kershaw — has been enriched with examples of Qing art from the Met's collection, including a large Castiglione drawing and a pair of panoramic scrolls depicting two of Qianlong's imperial road trips.

We also get something that in most museums we can only imagine: a real garden, in the form of the Astor Court. It's based on a Ming rather than a Qing prototype, but the components — twisty river rocks set in greenery — are right. And, because the Met's display cases are as shallow as they are tall, we can see everything in them close-up: the cloisonné medallions adorning a doorway surround, the stitch work in a satin chair cover, the chips of jade, coral and lapis lazuli embedded in a relief of a blossoming plum tree that comes across as both garish and sumptuous.

Up close was the emperor's perspective too: proprietary, absorbed, evaluative. And — who knows? — it may not be available again, once these objects return to Beijing and are placed, where they belong, in the completely restored Qianlong Garden that is scheduled to reopen in 2019, to what will surely be an avid new public.

Forbidden-City Treasure

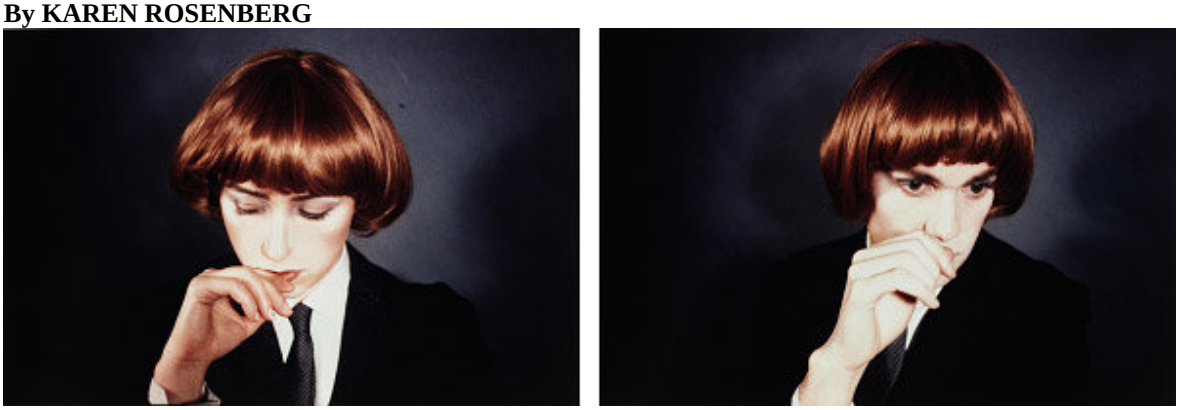
WHAT "The Emperor's Private Paradise: Treasures From the Forbidden City."

WHEN AND WHERE Through May 1, Metropolitan Museum of Art; (212) 535-7710, metmuseum.org.

http://www.nytimes.com/2011/02/04/arts/design/04emperor.html

Performance Art for an Audience of One

By KAREN ROSENBERG



Museum of Modern Art
"Staging Action: Performance in Photography Since 1960": "Untitled" (1980), a double portrait by Richard Prince and Cindy Sherman in this show at the Museum of Modern Art

During the last year the Museum of Modern Art has reinvented itself as a Museum of Performance Art. That change has been most pronounced in the temporary exhibition spaces, on the sixth floor and, especially, in the atrium. Now it's creeping into the permanent collection, with "Staging Action: Performance in Photography Since 1960," an exhibition of some 50 works drawn from the photography department, nearly half of them acquired over the last five years.

These aren't documents of live events, for the most part, but actions designed to be photographed. The camera is never really neutral, but here especially it's a co-conspirator. And some of the show's participants — Lee Friedlander, Richard Prince — are better known as photographers than as performance artists.

One might well ask whether an action staged exclusively for the camera, without a live audience, qualifies as a "performance." But that's just one of many questions MoMA has been asking over the last year or so, as it restaged Marina Abramovic's historical performances with new bodies and converted Warhol's films into digital installations. The museum, it seems, is betting that an engaging gesture by an artist-actor will transcend a single time, place and medium.

The better question is this: What can the still camera do for performers that a live audience (or, for that matter, a video) can't?

It can certainly isolate arresting, spectacular or just plain wacky moments. The show's title wall features a photograph by the Chinese artist Rong Rong; it shows another artist from "East Village" circle in Beijing, Zhu Ming, emerging from a head-dunking in sudsy water.

It can also serialize an action, as many of the works here do. In one set of four prints, the Chinese artist Ai Weiwei extends his middle finger toward important historical sites, including the White House and Tiananmen Square. William Wegman documents his daily shaving routine with a pair of before-and-after shots. And Adrian Piper comes close to making her body disappear, in a sequence of ascetic self-portraits that chronicle her fasting and meditation on Kant's "Critique of Pure Reason."

Sometimes the technology of the camera opens up new space for performance. In his "Auto Polaroid" shots from 1969-71 Lucas Samaras made a series of quick-change transformations with wigs, makeup and props, getting nearly instant feedback from the fast-developing prints. Is his mugging for the camera a form of solipsism, or exhibitionism?

Definitely exhibitionist is a project by Laurel Nakadate, which also serves as a teaser for her current solo at MoMA P.S. 1 in Queens. In a row of self-portraits she struts through Western landscapes wearing bikinis and crop tops. After taking the pictures, Ms. Nakadate enlisted male volunteers via Craigslist and encouraged them to handle the prints with inky fingers, the rather obvious conceit being that the photograph and the artist's body are objectified simultaneously.

Ms. Nakadate's series shares wall space with Lorna Simpson's vintage-glam arrangement of black-and-white pinup photographs, and a cheeky striptease-in-drag by the Fluxus artist George Maciunas. But it would have been interesting to see it in closer proximity to Valie Export's gutsy, guerrilla-feminist "Action Pants: Genital Panic," installed in a separate part of the gallery.

In this well-known 1968 performance, Ms. Export sauntered through an art-house theater in Munich wearing pants with the crotch cut out, teasing and testing the mostly male patrons. The confrontational image at MoMA (of Ms. Export splay-legged on a bench) is a re-enaction, though it acquired a life of its own when she had it screen-printed and posted it around town.

Ms. Export was reacting to a local contemporary-art scene, Viennese Actionism, that was mostly male. The show devotes a lot of space to this endurance-testing movement, with works by Otto Muehl, Hermann Nitsch, Günter Brus, and Rudolf Schwarzkogler. Mr. Schwarzkogler's "3rd Action" (1965-6) is not for the timid, with its visions of mummylike, gauze-wrapped heads and mutilated genitals.

But for every strenuous performance in the show (organized by Roxana Marcoci and Eva Respini, curator and associate curator in the photography department), there's a playful one. You can't help but chuckle at Bruce Nauman's facial gymnastics in "Studies for Holograms," or Ana Mendieta's bleached-orange hair and foundation-caked eyebrows in her "Untitled (Facial Cosmetic Variations)."

Funniest of all is Cindy Sherman and Richard Prince's double portrait, two color prints showing both artists as androgynous identical twins in black suits and red pageboy wigs. The piece dates from 1980; three decades on, it's a fabulous art-world in-joke, the king and queen of the "Pictures" generation playing court jester.

Mr. Maciunas made a similar statement about gender in his 1978 wedding to the poet Billie Hutchins; both bride and groom wore wedding gowns and later exchanged clothing. That event was intended as a live performance (though photographs do exist), so it isn't documented here. You can, however, see Mr. Maciunas peeling off black lingerie in an earlier series of shots titled "Cross-Dressing Ballet" (1966). As he strips, he's participating in a different, more private kind of ceremony, one that's between the performance artist and the camera.

"Staging Action: Performance in Photography since 1960" continues through May 9 at the Museum of Modern Art, (212) 708-9400, moma.org.

http://www.nytimes.com/2011/02/04/arts/design/04staging.html?ref=design

Will intensified farming save the rainforests?

- 09 February 2011 by **Fred Pearce**
- Magazine issue 2798.

Relieving pressure on the rainforest? (Image: shutterstock.com)

The idea that you can save the natural world by increasing the efficiency of agriculture is very appealing. This writer is far from convinced

INTENSIFYING agriculture is never going to be the new rock 'n' roll, but the idea is pretty fashionable right now. Last week a major study led by the UK government's chief scientist John Beddington warned that the only way to feed the world is to produce more food from the same amount of land.

Some say that misses the point: we already produce enough food to feed 10 billion people, if only we didn't waste so much. But there is another argument for intensifying agriculture: to save the rainforests. At last December's climate conference in Cancún, Mexico, many delegates called for investment in farming to be included in REDD, the fund that will pay tropical countries to protect their rainforests and the carbon they lock away.

The argument runs like this. As demand for food increases, farmers - already the biggest destroyers of forest - are likely to chop down yet more trees. So to prevent further destruction, we urgently need to intensify agriculture. As climate economics guru Nicholas Stern put it in Cancún: "Cattle pasture in Brazil has only one animal per hectare. Raise that to two and you can save the Amazon rainforest." The Brazilian government's strategy is based on exactly that premise. The World Bank, which will run the fund, made the same pitch.

The idea that intensifying agriculture relieves pressure on land is sometimes called the Borlaug hypothesis after Norman Borlaug, the pioneer of the green revolution, who first articulated it. But before we go ahead we had better be sure that it is true.

The counter-argument is that farmers don't clear forests to feed the world; they do it to make money. So helping farmers become more efficient and more productive - especially those living near forests - won't reduce the threat. It will increase it.

Tony Simons, deputy director of the World Agroforestry Centre in Nairobi, put it this way in Cancún. "Borlaug thought that if you addressed poverty in the forest border, they'd stop taking their machetes into the forest. Actually, they get enough money to buy a chainsaw and do much more damage."

One recent study seems to bear out this contrarian view. Thomas Rudel of Rutgers University in New Brunswick, New Jersey, compared trends in national agricultural yields with the amount of land under crops since 1990. If Borlaug was right then where yields rose fastest, the rise in cropland should be least. It might even go into reverse.

No such luck. Mostly, yields and cultivated area rose together. Rudel compared the finding to the Jevons paradox, named after the 19th-century economist William Jevons who found that increasing the efficiency of coal burning led to more, not less, coal being burned (*Proceedings of the National Academy of Sciences*, vol 106, p 20675).

That's not to say intensification isn't needed - the world has to be fed, after all. But it won't necessarily save the forests. Any climate protection scheme that assumes it does is likely to be handing out money for nothing.

***Fred Pearce** is New Scientist's environment correspondent. The paperback edition of his book Peoplequake is published this week (Eden Project Books)*

http://www.newscientist.com/article/mg20927986.200-will-intensified-farming-save-the-rainforests.html

US military promotes peace in space

- 16:23 08 February 2011 by **Paul Marks**

All for one and one for all (Image: NASA Marshall Space Flight Center)

Spacefarers take note: an attack on the spacecraft of one nation is an attack on all spacecraft.

That's the message the US National Security Space Strategy is using to promote peace in space. Published last week, the NSSS report is the first time that the US military and intelligence community have agreed on an approach to the threat posed by space weapons.

Many nations rely on GPS and communications satellites, but these are vulnerable to damage if another spacecraft is attacked. For example, satellites are still at risk from the thousands of shards that were produced when a Chinese missile destroyed a weather satellite in 2007.

So the US intelligence agencies and Pentagon will "encourage other countries to act responsibly in space", says Gregory Schulte, US deputy secretary of defence for space policy. That means forming international alliances that promote "norms" of behaviour in orbit that are designed to prevent deliberate or accidental debris creation.

Attack one, attack all

Laura Grego, a specialist in space security at the Union of Concerned Scientists in Cambridge, Massachusetts, welcomes the new strategy.

"It's a thoughtful and carefully written document with a lot of really positive things in it," she says. Grego also approves of highlighting the negative impacts of aggressive behaviour in orbit.

Establishing coalitions also makes sense, says security commentator John Pike of defence think tank GlobalSecurity.org. "Creating partnerships means an attack on one is an attack on all," he says. The norms will get across the message that "it is not nice to shoot at satellites", Pike adds.

But while Steven Aftergood at the Federation of American Scientists in Washington DC says that "the government deserves a bit of credit for addressing these delicate issues in a public way", he would like more detail on how exactly the strategy will be implemented.

http://www.newscientist.com/article/dn20099-us-military-promotes-peace-in-space.html?full=true&print=true

Seeding the galaxy with Earthly life

- 09 February 2011 by **Stephen Battersby**
- Magazine issue 2798.

Go forth and multiply (Image: L Allen (Harvard-Smithsonian CFA)/D. Padgett (SSC-Caltech/NASA)

Editorial: "To boldly sow: why we should fertilise the galaxy"

If there is no life on other planets, let's send it there

EARTH'S first interstellar expedition seems to be a disaster. During the long journey most of the passengers die from radiation sickness. When at last the spacecraft arrives, it crash-lands on the surface of a bleak and barren world. The capsule splits open and the alien air finishes off many of the remaining explorers. Over the ensuing days, some of the few survivors succumb to the extreme temperatures, while others die after drinking from pools of acid.

But one stalwart survives. Soon there is even better news: our explorer divides into two clones. Earth life reproduces for the first time under the light of an alien star. Its offspring mutate and begin to adapt to their new home, eventually spreading across the planet and evolving into new forms of life. That's one small step for a bug, one giant leap for bugkind.

Why would we want to replace Captain Kirk with a bacterium? Because the dream of humans travelling to other stars, while not impossible, may yet turn out to be unfeasible.

If we can't go in person, then instead we could recruit our single-celled cousins as astronauts. "We are at a point now where we almost have the ability to send micro-organisms to other worlds," says Michael Mautner of Virginia Commonwealth University in Richmond. "We can generate a vast amount of life in the universe. It would give our own existence purpose."

The idea that simple life forms could be carried from planet to planet, known as panspermia, is an old one. Ever since the 19th century, scientists have been debating whether life could survive the long journeys between star systems. Mautner thinks the process should not be left to chance.

"I started to become interested in the 1970s, at the height of the cold war and the nuclear arms race, when there were questions about whether we were going to survive," he says. "What if Earth has the only life? Earth will be destroyed eventually, then all life is gone. For me that's a very empty and meaningless universe." The answer, he concluded, is that we should become the agents of panspermia.

He is not alone in advocating directed panspermia, as this idea is known. "Expanding the richness of life in the universe is what we ought to be doing," says Chris McKay, an astrobiologist at the NASA Ames Research Center in Moffett Field, California.

Mautner outlined his ideas for spreading Earth life across the galaxy in a recent paper (*Journal of Cosmology*, vol 5, p 982). He envisages sending out colony ships filled with microbes and pulled by solar sails. The first solar-sailing craft was launched by Japan's space agency last year, and by Mautner's calculations such craft could reach speeds of up to 150 kilometres a second by swooping close to the sun before unfurling their sails.

Where should we send the first microvoyagers? The obvious target is a young, temperate rocky planet similar to Earth, the kind of planet we may soon start to find thanks to NASA's Kepler mission, launched in 2009. A seeding mission could aim to put a spacecraft in orbit within the habitable zone around the host star, from where it could disperse millions of seed capsules, some of which should end up on the target planet.

But this would not be easy. Such a distant stellar target would need precise targeting, and more critically, the craft would have to slow down to enter orbit around the target star. It could decelerate by using its solar sail to catch the light of the star, but it is not clear whether this would be possible without an active guidance system, which would have to remain in working order for tens of thousands of years. "I would like to stay away from any far-future technologies if possible," says Mautner.

In that case, a softer target might be a disc of gas and dust around a young star, such as Beta Pictoris, 63 light years away. Here the tactics of the swarm come in: "If you send billions of small vehicles, hopefully some will arrive," says Mautner. Each vessel could hold 100,000 freeze-dried bacteria in a capsule just 40 micrometres across, towed behind a sail less than 4 millimetres across. When these seed pods arrive, drag from the gas in the disc would slow them down. As comets and rocky bodies form in the disc, says Mautner, some seed pods will become incorporated and eventually a few should end up on the surfaces of planets.

The journey will take a long, long time. Even at a speed of 150 kilometres per second, the trip to Beta Pictoris would take more than 120,000 years. Can any living organism survive such an epic voyage in space? "That is the biggest open question," says Mautner.

The toughest passengers may be freeze-dried bacteria, which are often stored for long periods in laboratories. Some bacteria can dry themselves out and produce a hardy dormant form called an endospore. There are controversial claims of endospores being revived after being locked in amber for 40 million years, or after being trapped in salt crystals in a cave in New Mexico for 250 million years. Even if some bacteria really can snooze for a quarter of a billion years, though, they are far less likely to survive in space than in a cave.

Dead on arrival

The big danger is cosmic rays - energetic protons and other charged particles that can smash up DNA. We are shielded from most cosmic rays by Earth's atmosphere and the solar wind, but in interstellar space the microbe passengers of a small seed capsule would face the radiation unprotected.

We know that they could cope for a few years, at least. Bacteria have survived for more than 18 months outside the International Space Station. Much longer-term exposure would be more challenging, but might not be terminal, says Lewis Dartnell of University College London, who studies the potential for microbes to survive on Mars. "The numbers might work out if you can send enough microbial voyagers in each capsule. The vast majority would die on the way from radiation, but a tiny fraction would survive." After a million years with negligible shielding, he calculates, about one in a million freeze-dried bacteria would remain alive. At the solar-sail speeds envisaged by Mautner, a million years is long enough to travel 500 light years.

Then again, maybe it does not matter if the bugs are dead on arrival. Last year, Paul Wesson of the Herzberg Institute of Astrophysics in Canada suggested that even the shattered corpses of microbes, just fragments of DNA and other biomolecules, could help life to emerge. He called the idea "necropanspermia".

Alternatively, shielding a few metres thick on the spacecraft would cut out the bulk of cosmic ray damage. Another solution might be to revive the passengers from time to time so they can repair any DNA damage, before suspending their animation again. These options would require much larger spacecraft, though, which would spoil one of Mautner's aims - to make directed panspermia relatively cheap. After all, a project that

may not bear fruit for billions of years, and whose success or failure may never be known, seems unlikely to attract vast funds.

The cost of Mautner's lower-tech approach depends on a lot of factors. How many capsules must land on a young planet, say, to achieve a fair chance of some bug becoming established? Mautner guesses a hundred, although McKay feels that is optimistic. "The chances of any particular organism growing or any particular capsule falling on fertile ground is vanishingly small," says McKay. "The good thing is that it's easy to make billions of them."

Billions, perhaps many billions, will be needed. Even the closest planetary systems are tiny targets, and most capsules will miss altogether. They are also moving targets, and we will need ultraprecise measurements of their motions before an unguided mission could succeed. That should be possible with space-based telescope arrays within a few decades, Mautner says.

Marc Millis of the Tau Zero Foundation, which promotes research into interstellar travel, is sceptical. "It's hard to hit interstellar targets, and it is much harder to hit targets with passive sails than with a vehicle that can correct its course as it goes along."

Aim becomes less of a problem in one of Mautner's grander plans. He hopes to seed entire star-forming regions holding dozens of new stars, such as the Rho Ophiuchi cloud, about 500 light years away. That is a big target, no problem to hit. On the downside, such large-scale carpet-bombing would probably need millions of times as many seed capsules as a single planet or planet-forming accretion disc. And once there, most of the intrepid bugs might have wait millions of years, all the while exposed to the hard rain of cosmic radiation, before anything solid forms.

If fleets of simple spacecraft can't do the job, a more high-tech approach will be needed. Sails propelled not by sunlight but by huge lasers in Earth orbit could theoretically reach speeds of thousands of kilometres per second, slashing travel time and radiation exposure, and they could probably be aimed more precisely than sun-catching sails. Advanced robotics could even guide microbial passengers to the most promising havens on new worlds.

While the challenges are huge, there is no doubt that it will be easier to send bacteria than people. They are only very distant cousins of ours, but as far as Mautner is concerned, kin is kin. "Life is one big family, and the purpose of life is to propagate," he says. "If we manage to seed life on a few hundred planets, we can start many chains of evolution. Hopefully some will evolve into intelligent beings."

McKay agrees. "When we look around the universe we see a lot of different things, but the thing that is most interesting, the only thing that is a source of value, is life," he says. "I like the argument that humans should seek to expand the richness and diversity of life."

Complete annihilation

There is a risk that we would be doing the opposite, however. The presence of Earth colonists might prevent new forms of life evolving from scratch. Worse still, the colonists might kill off native life forms.

Consider the opposite situation. "How would we react if another civilisation sent to Earth a directed panspermia package containing alien microbes, and it affected the Earth's biosphere in a negative way?" asks astrobiologist and writer Barry DiGregorio, affiliated with Cardiff University in the UK. If we cannot be sure that microbes won't harm existing life, then we shouldn't send them, he says. "The only reason I can think of to try it, as a last resort, is if the Earth was facing complete annihilation by an impending solar event, asteroid or comet catastrophe."

Others are less worried. "My feeling is that any natives, adapted to their environment, would be better equipped and so outcompete the new arrivals," says Dartnell, "but that might not always be the case."

Proposed space telescopes such as NASA's Terrestrial Planet Finder could check for signs of life on other worlds before capsules are sent. They would not be able to detect the early stages of life, Dartnell says, but they should reveal where a biosphere is well established. If these searches do not find any such signs, it will be evidence that life does not readily get started and needs our helping hand.

If, on the other hand, life is found to be plentiful, there would be no need for directed panspermia. A galaxy teeming with aliens might be a sign that life evolves readily, or spreads rapidly between star systems by natural panspermia, or both. Or maybe, as Carl Sagan suggested in 1966, another civilisation had this idea billions of years ago and successfully spread their seed throughout the galaxy. Was our ancestor the lone survivor of a tiny starship that crash-landed on a bleak and barren planet far from home?

Read more: For a different point of view, see **Barry E. DiGregorio**'s Comment article "Don't send bugs to Mars"

The right stuff

If we want to seed distant planets with life, what should we send? The first challenge is to survive the journey, which makes Deinococcus radiodurans - aka Conan the Bacterium - a tempting choice. It is not only extraordinarily radiation-resistant, but can also survive extreme cold and dehydration. However, *D. radiodurans* cannot form long-lasting endospores and it needs oxygen and organic compounds, which won't be available on a barren new world.

What might be available is methane, hydrogen or sulphide compounds, food to microbes like the ones found around deep-sea vents. "As long as they find an ocean, they could probably find a living," says Lewis Dartnell of University College London. Other obvious candidates include photosynthetic organisms such as cyanobacteria, which could make their own food and produce oxygen into the bargain, although it might take billions of years for oxygen to reach the levels that animals need.

Fertile ground should not be hard to find. Michael Mautner of Virginia Commonwealth University in Richmond has grown algae and even small asparagus plants in pulverised chunks of meteorites (*Icarus*, vol 158, p 72). "The material is as productive as agricultural soil here on Earth," he says.

Mautner is not planning to sow the galaxy with asparagus, but he does speculate about sending more advanced organisms. It may have taken almost 2 billion years for complex cells to evolve from bacteria, and sending single-celled algae, for example, might bypass an evolutionary bottleneck and speed up the appearance of multicellular organisms. Complex cells would be far less likely to survive an epic trip, though.

To maximise the chances of a few microbes surviving, Mautner suggests sending a diverse mix of simple cells, including extremophiles that thrive in high or low temperatures, fierce acidity and so on. Better still, genetic engineers could create superbugs able to survive extended space travel, exploit many different energy sources and live in a wide range of environments.

***Stephen Battersby** is a consultant for New Scientist based in London*

http://www.newscientist.com/article/mg20927981.800-to-boldly-sow-seeding-the-galaxy-with-earthly-life.html?

Betting on the multiverse

- 07 February 2011 by **Amanda Gefter**
- Magazine issue 2798.

Thoughts racing along parallel lines (Image: Bebeto Matthews/AP/PA)

*Physicist **Brian Greene** was propelled into the spotlight thanks to* The Elegant Universe, *his bestseller on string theory. Now he's turned his attention to parallel worlds. He tells **Amanda Gefter** about his favourite multiverse, why we might be living in a computer simulation and the questions that keep him awake at night*

Why did you decide to write about parallel universes in your new book, *The Hidden Reality*?

I think it's important for the general public not just to learn about science that's all settled, confirmed and in textbooks, but also to capture a picture of vital science in the making. That's the stage we're at now when it comes to the idea that our universe may be one of many. If it's right, it's hard to imagine a greater upheaval to our understanding.

In the book you talk about many different types of multiverse...

Yes, I chose to focus on nine versions of the multiverse. But as far-out as the notion of parallel worlds sounds, it's not as though we physicists are saying 'what crazy idea can we think of next?'. Rather, what we find with many fundamental theories, if we pursue them to their logical, mathematical conclusion, is that they all seem to bump into one or another version of parallel universes. It's almost harder to avoid the idea than it is to dream it up.

Could these nine different types of multiverse ultimately be the same?

It's conceivable that all nine types of multiverse are separate ideas, and that one or a few, or all of them are real or maybe none of them are. But some interesting potential relationships between them have emerged. For example, in the 1950s, the physicist Hugh Everett came up with the "many worlds" interpretation of quantum mechanics, which says if quantum mechanics predicts that X, Y and Z are possible, with different

probabilities, then X, Y and Z will actually happen. All possible outcomes occur, but in different universes. That bears potential similarity to another kind of multiverse - the kind that arises if space is infinite.
In any finite region of space, matter can only arrange itself in finitely many different configurations, much as a deck of cards can be arranged in only finitely many different orders. If you shuffle the deck infinitely, the card orderings must necessarily repeat. Likewise, if the universe stretches on forever, the arrangement of particles will repeat too. That would mean that you and I are having this conversation out there, perhaps over and over, an infinite number of times. In both of these multiverses, every possible outcome is happening somewhere in some universe.

You mention in the book that you've never seen physicists quite so heated as they are over the multiverse. Why all the drama?

Physicists love to argue, but usually they're arguing about some detail of science like how to interpret a piece of data. When it comes to the multiverse, the nature of the argument is different. It becomes a meta level of argument: are multiverse proposals scientific? This debate has caused some antagonism, but my feeling is, when people fight it out passionately, that's always a good thing for science.
The tension hinges on this: can you measure or access other universes, and if not, how can they count as science? I had that reaction too, when I first encountered these ideas. But as I delved into them more deeply it became clear that just because you're invoking other universes does not mean you stand outside of falsifiability or testability. I think we have to be very careful about writing off this kind of pursuit too quickly, because it could well be the right direction.

What kinds of experiments could show evidence of parallel worlds?

We have no concrete evidence today of parallel universes. But there are multiverse scenarios in which we might have access to other universes. There's the inflationary multiverse, for instance. This is the idea that our big bang was not a single event - instead, there are many, perhaps infinite, big bangs, each giving rise to its own universe. You can think of all these different universes as bubbles in a bubble bath. Sometimes, the bubbles collide and if our universe has collided with another universe, we might see evidence of that in patterns in the microwave background radiation left over from the big bang. That would be a very direct way of establishing that there are other universes out there.

Would the existence of parallel worlds have any impact on our daily lives?

My view is that if you want to really understand yourself and life more generally, you have to know what reality is, where it came from, what properties it has that you may not be aware of. I desperately want to know what the true nature of reality is, because I feel that it helps me get a firmer grasp on why I'm here and how we relate to this grand and strange cosmos that we find ourselves within.
So when I'm in the grocery store buying orange juice, does it affect me? Not at every moment. But when I'm walking along and thinking about the nature of life and the work that I do, does it affect me? It does, because these ideas affect my sense of what's real.

One kind of parallel universe that really challenges one's sense of reality is the idea that we are living in computer simulation. Do you ever think to yourself, wow, this might all be a simulation? And if it is, does it matter?

I catch myself thinking about simulations when I'm looking at my kids. When I see them doing things that are so unexpected, it's hard for me to imagine that some computer simulation came up with that behaviour. I know that doesn't hold much water, because a good enough computer simulation might do so.
Would it matter? In a way it wouldn't. If I have been simulated for all the years I've been on this Earth, it's been a fun ride. If The Simulator is listening to me right now: keep it going! You know, it's been good. And the fact that we can use our minds, even if they are simulated minds, to apparently gain insight into the world, even if it's simulated insight, is exciting.

You can imagine people reading religious connotations into The Simulator

The thing to bear in mind is that The Simulator of these simulated worlds would still be subject to some rock-bottom laws of physics. They would not require supernatural understanding, the way we generally envision that some divine being would.

If you had to bet money on whether or not there's a multiverse and which kind, what would your bet be?

I'd say three things. I'm particularly fond of the brane multiverse, which is the idea from string theory that we may be living on a membrane that is floating in a higher-dimensional space. I think there's a chance that we

may test it very shortly. The Large Hadron Collider has the capacity, at least in principle. If, in the course of a particle collision, some debris exits our brane, we could recognise that by seeing a loss of energy in our universe.

I'm also excited by the string landscape multiverse. When you put together the idea of eternal inflation - infinite big bangs - with the extra dimensions of string theory, you get the string multiverse, which says that all the different universes produced by inflation are characterised by different shapes for the extra dimensions. I have a bias toward that, because I've been working on the extra dimensions of string theory since I was 22 years old. Finally, in terms of mind-bending, the idea of infinite space giving rise to endless duplications of us is so shocking because it's so simple. We just have to wait to see if any of them are right.

If you could go into any other profession, what would it be?

Probably music. To me music has a capacity to directly tap into something that feels transcendent or eternal. And that's why I do science, too. I like the notion that what we're revealing may be eternal truths, fundamental threads in the tapestry of reality. But I think there are other ways of tapping into that kind of eternality and music is one of them.

Is there any question that keeps you up at night?

I wish it was just one. There are two that, if I allow myself to think about them, make my heart sink. Why is there something rather than nothing? It's a simple question that's been asked for so long and the idea of nothing seems to me logically sensible. But when I truly imagine nothingness, well, I find it almost scary. Why *isn't* there nothing?

The other question is the nature of time. Time is with us, every moment. I can't even say a sentence without invoking a temporal word - moment. But what is time? When we look at the mathematics of our current understanding of physics, time is there, but there's no deep explanation of what it is or where it came from.

Profile

Brian Greene has a physics degree from Harvard University and a PhD from the University of Oxford. Specialising in string theory, he is now co-director of the Institute for Strings, Cosmology and Astroparticle Physics at Columbia University, New York. His latest book is *The Hidden Reality: Parallel universes and the deep laws of the cosmos*. He is the organiser of the World Science Festival

http://www.newscientist.com/article/mg20927986.500-bestselling-string-theorist-betting-on-the-multiverse.html

First lasers grown directly on silicon chips

- 17:44 07 February 2011 by **Jeff Hecht**

The elusive goal of integrating lasers and electronics has come a big step closer with the first growth of nanoscale lasers directly on silicon. The tiny lasers are made from compound semiconductors that can emit light far more efficiently than silicon itself can.

Integrating optical processing into electronic chips holds great promise for high-performance computing. Electronics are very good at processing information because electrons interact strongly with each other. However, as electrons are moved to transfer information, those interactions also cause background noise and weaken the signal, and so cutting-edge chips are pushing the limits of what electrons can do carrying signals on circuit boards and in the chips themselves.

In contrast, photons have little effect on each other, so they can transfer information much more efficiently than electrons. That's why fibre-optic cables have replaced wires in the main circuit boards of high-performance computers as well as in cables running kilometres or more.

Computers suffer a crucial limitation when it comes to working with light, however: although silicon can transmit and detect light signals, it can't generate light efficiently. Compound semiconductors such as gallium arsenide and indium phosphide are needed to make good lasers. Chip maker Intel and the University of California, Santa Barbara, have succeeded in bonding indium-phosphide lasers to silicon so tightly that light generated in the indium-phosphide layer is transferred into silicon light guides. However, such bonding is costly and cannot be integrated into standard chip manufacture, and it hasn't been possible to "grow" lasers made of those materials on silicon.

Growing lasers

Now Connie Chang-Hasnain's group at the University of California, Berkeley, has overcome the crystalline mismatches between silicon and gallium-arsenide compounds that had blocked laser growth. That let them grow tapered hexagonal pillars of indium-gallium arsenide with bases only about half a micrometre across onto silicon chips. The semiconductors were grown using chemical vapour deposition in the same way that LEDs are created. These nanopillars act as lasers when an external laser shines on their top: the laser light bounces around inside the pillar, following a helical path from top to bottom, where some of the light leaks out.

In practical applications, the researchers expect that the nanolasers will be able to produce their own light, without the need for an external laser.

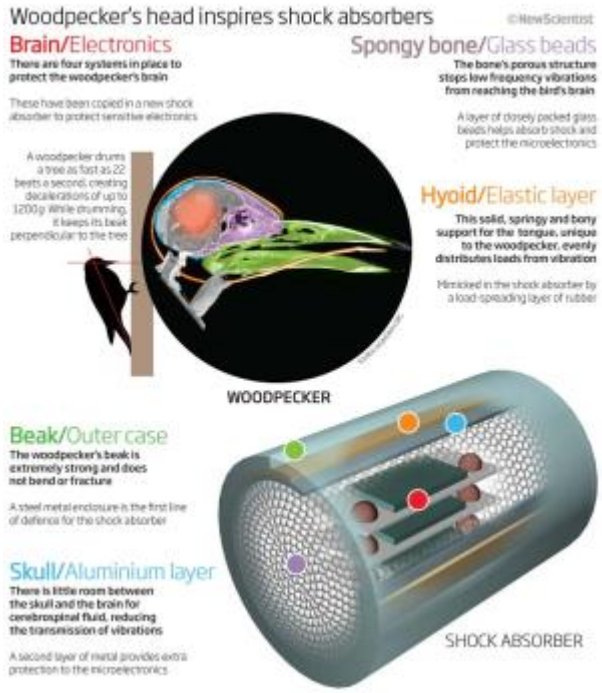
This demonstration is a crucial step on the path to integrating optics and electronics, but many remain to be made before we reach the goal, says lead author Roger Chen, also at the University of California, Berkeley. Other key challenges that remain include transferring light from the laser to a light guide in the chip, and modulating the light.

Journal reference: *Nature Photonics*, DOI: 10.1038/nphoton.2010.315

http://www.newscientist.com/article/dn20096-first-lasers-grown-directly-on-silicon-chips.html

Woodpecker's head inspires shock absorbers

- 15:16 04 February 2011 by **Paul Marks**



Woodpecker vs shock absorber

When aircrash investigators of the future retrieve a flight recorder from the wreckage of a plane they may have the golden-fronted woodpecker, Melanerpes aurifons, to thank for the survival of the flight data. The reason? A shock absorber inspired by the bird's ability to withstand severe deceleration.
A woodpecker's head experiences decelerations of 1200*g* as it drums on a tree at up to 22 times per second. Humans are often left concussed if they experience 80 to 100*g*, so how the woodpecker avoids brain damage was unclear.
So Sang-Hee Yoon and Sungmin Park of the University of California, Berkeley, studied video and CT scans of the bird's head and neck and found that it has four structures that absorb mechanical shock.
These are its hard-but-elastic beak; a sinewy, springy tongue-supporting structure that extends behind the skull called the hyoid; an area of spongy bone in its skull; and the way the skull and cerebrospinal fluid interact to suppress vibration.

Artificial analogues

The researchers then set out to find artificial analogues for all these factors so they could build a mechanical shock absorbing system to protect microelectronics that works in a similar way.
To mimic the beak's deformation resistance, they use a cylindrical metal enclosure. The hyoid's ability to distribute mechanical loads is mimicked by a layer of rubber within that cylinder, and the skull/cerebrospinal fluid by an aluminium layer. The spongy bone's vibration resistance is mimicked by closely packed 1-millimetre-diameter glass spheres, in which the fragile circuit sits (see diagram).
To test their system, Yoon and Park placed it inside a bullet and used an airgun to fire it at an aluminium wall. They found their system protected the electronics ensconced within it against shocks of up to 60,000*g*. Today's flight recorders can withstand shocks of 1000*g*.
"We now know how to prevent the fracture of microdevices from mechanical shock," says Yoon. "An institute in Korea is now looking into some military applications for the technology."

Overcoming space debris

As well as a possible role protecting flight recorder electronics, the shock absorber could also be used in "bunker-busting" bombs, as well as for protecting spacecraft from collisions with micrometeorites and space debris. It could also be used to protect electronics in cars.

"This study is a fascinating example of how nature develops highly advanced structures in combination to solve what at first seems to be an impossible challenge," says Kim Blackburn, an engineer at Cranfield University in the UK, which specialises in automotive impact studies.

"It may inform our thinking on regenerative dampers for vehicles, redirecting the energy into a form more easily recoverable than dumping it to heat," Blackburn adds. "Ultimately, we need to learn from the woodpecker to recover energy and not give the driver a headache."

Nick Fry, chief executive of Formula One team Mercedes GP Petronas based in Brackley, UK, says such ideas could feed into crash protection for drivers taking part in motorsport: "One big issue with Formula One is protecting the driver by getting them to decelerate in an accident situation in such a way that his internal organs and brain aren't turned to mush."

"We do that with clever design of composites, very sophisticated seatbelts and a head and neck restraint system," Fry says. "But this research might be something we can draw on in future – it could be very interesting."

Journal reference: *Bioinspiration and Biomimetics*, DOI: 10.1088/1748-3182/6/1/016003

http://www.newscientist.com/article/dn20088-woodpeckers-head-inspires-shock-absorbers.html

Without language, numbers make no sense

- 20:00 07 February 2011 by **Bob Holmes**

How many can you count? (Image: CJ Burton/Corbis)

People need language to fully understand numbers. This discovery – long suspected, and now backed by strong evidence – may shed light on the way children acquire their number sense.

Previous studies of Amazon tribes who lack words for numbers greater than three – or, in the case of the Pirahã, for any numbers at all – had shown that they struggle to understand precise quantities, when numbers are relatively large.

However, it wasn't clear whether this is because they lacked words for larger numbers, or because they came from a culture that viewed precise numbers as unimportant.

Now Elizabet Spaepen, a psychologist at the University of Chicago, and her colleagues may have settled the question. The team studied profoundly deaf people from Nicaragua who had created their own sign language to communicate.

Wordless numbers

These "homesigners" live in a numerate culture, holding jobs and using money, yet lack any vocabulary for numbers. So the researchers reasoned that any difference in their numeracy must be down to language alone.

Spaepen's team tested their number sense by asking four homesigning adults to summarise picture stories in which numbers played an important part, for example a story featuring 10 sheep in a pen. Spanish-speaking Nicaraguans who weren't deaf and deaf people who used American Sign Language performed these tasks almost flawlessly.

In contrast, homesigners were only accurate at counting the smallest numbers. Beyond three or four they were often imprecise, for example holding out nine fingers to represent 10 sheep.
In a further task, homesigners were given a set of objects and asked to use tokens to create a second set containing the same number of tokens as objects. Again, their accuracy dropped significantly above sets of three objects.
"They're not wildly off," says Spaepen. "They can approximate quantities, but they don't have a way of getting to the exact number."

Count list

Spaepen's experiments did not reveal which component of language is crucial to developing an accurate number sense. However, she suspects that it is the "count list" – the familiar sequence of numbers that every speaking child learns early on.
Children learn this count list well before they actually understand that "four" refers to four objects rather than three or six, says Michael Frank at Stanford University in California.
Journal reference: *Proceedings of the National Academy of Sciences*, DOI: 10.1073/pnas.1015975108

http://www.newscientist.com/article/dn20095-without-language-numbers-make-no-sense.html

Zapping the brain sparks bright ideas

- 10:27 03 February 2011 by **Janelle Weaver**

A new strategy might help (Image: Wade Griffith/Getty)

Ever wished you could think more laterally to solve a problem? In future, maybe you'll just use a bit of mind-boosting technology: zapping the brain with electricity helps people think outside the box to solve a task.

Transcranial direct current stimulation (tDCS) is a safe and non-invasive method of temporarily altering the activity of neurons by passing weak currents through electrodes on the scalp. It can enhance mathematical skills, memory, attention and language learning.

Richard Chi and Allan Snyder of the University of Sydney in Australia wondered whether it would help people solve brain-teasers. They began by training 60 volunteers to solve arithmetic problems expressed in Roman numerals constructed from matchsticks. The point of this was to get their brains in the habit of solving problems in a particular way: the participants corrected false calculations by moving matchsticks around to create different numbers.

The volunteers then worked on two further matchstick problems that required a different approach, swapping an equation's symbols, such as "−" and "÷", while they received tDCS over their anterior temporal lobes (ATL), brain structures found on each side of the brain near the temples. Chi and Snyder focused their attention on the ATLs because the right-hand one is known to be involved in perceiving the world in a new light.

Some participants received an excitatory current over the right hemisphere of the brain and inhibitory current over the left, while others experienced the opposite pattern or a sham treatment.

Stimulating solution

Excitation of the right hemisphere and inhibition of the left made the participants three times more likely to figure out the correct answer within 6 minutes compared with those who received the sham treatment.
The authors say this result confirms that the right ATL is associated with insight and novel meaning. It also backs up previous findings that the left ATL is involved in processing routine strategies and the maintenance of existing hypotheses. The combination of excitation and inhibition may force participants to examine problems with fresh eyes instead of relying on old routines, say the authors.
"It's intriguing when brain stimulation leads to improved performance, because typically you find that this type of manipulation is disruptive," says Jonathan Schooler, a psychologist at the University of California, Santa Barbara.
Schooler says that the tDCS could have disrupted the strategies and cognitive processes used to solve the first set of calculations, and that this helped the subjects switch to a new strategy more effectively. The authors should use additional tasks to determine whether stimulation of the ATL affects other forms of insight, he says.
Journal reference: *PLoS One*, DOI: 10.1371/journal.pone.0016655

http://www.newscientist.com/article/dn20080-zapping-the-brain-sparks-bright-ideas.html

Vikings' crystal clear method of navigation

- 18:00 31 January 2011 by **Andy Coghlan**
- Magazine issue 2798.

No sun here (Image: Doughoughton/Alamy)

Viking sagas may have been more truthful than we realised. Crystal "sunstones" could have helped Viking sailors to navigate even when cloud or fog hid the sun.

Vikings navigated using sundials calibrated to show the direction of the North Pole. While there is no physical evidence for the navigational techniques adopted on cloudy days, there are references in the Viking sagas to "sunstones" being used.

In 1967, Danish archaeologist Thorkild Ramskou suggested that sunstones may work by creating a pattern of light that revealed the hidden sun's location – although sceptics countered that the method is unwieldy, if not unworkable.

It is only within the last 10 years that Ramskou's theory has been put to the test, and the results, summarised in *Philosophical Transactions of the Royal Society B* (vol 366, p 772), claim to demonstrate that the sunstone method does work in cloudy or foggy conditions.

Sunstones – translucent crystals of minerals such as calcite – are potentially useful because both they, and the atmosphere, behave like natural Polaroid filters. This means they polarise light, causing its photons to vibrate in only one plane. Crucially for this navigation technique, the atmosphere leaves sunlight polarised in a series of concentric rings centred on the sun.

Pinpoint the sun

It is this pattern that can be detected using a sunstone – at least in theory. When the crystal is pointed skywards and rotated, the theory goes, the light passing through it progressively brightens and dims, depending on whether the crystal's direction of polarisation is aligned or misaligned with the polarisation rings in the atmosphere. When the two are aligned, the crystal appears at its brightest and points towards the sun – even if the sun is hidden. Taking two readings at different points in the sky should enable a navigator to pinpoint the sun's position.

Once the position of the sun was established, Ramskou speculated, Viking navigators could hold a lighted torch in the correct position above their sundial, giving them the required shadow reading on the dial.

However, critics say that too little polarised light passes through clouds to take accurate readings using a sunstone. So to settle the dispute, Gábor Horváth at Eötvös University in Budapest, Hungary, and colleagues studied polarisation patterns under cloudy skies and foggy conditions in Hungary, Finland and within the Arctic circle.

Using a polarimeter, which determines light's angle of polarity, Horváth's team found that the atmospheric polarity patterns can be detected even under cloudy skies or foggy conditions, suggesting that the Vikings

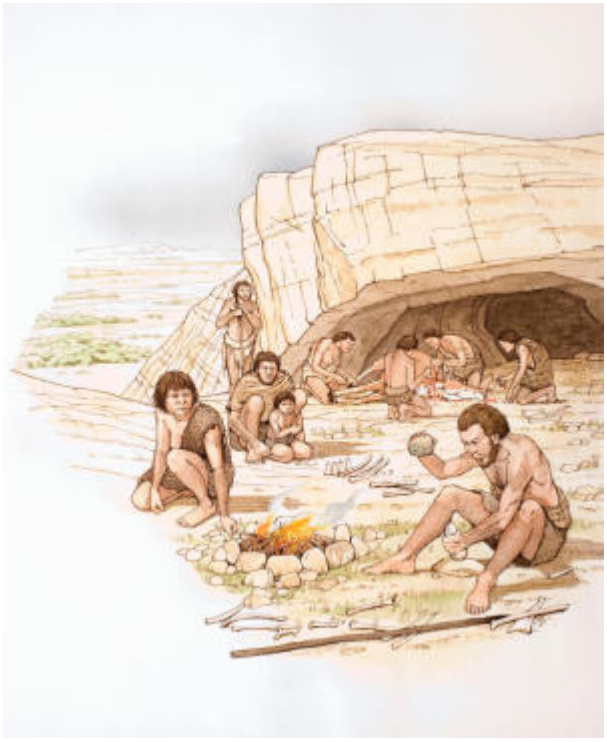
could have made use of them. The patterns are difficult to detect under completely overcast conditions, however.

Despite the latest evidence, not everyone is convinced. "The sky is strongly polarised only in certain regions relative to the sun," says Tom Cronin of the University of Maryland, Baltimore, and an authority on polarisation. "If the light's not very polarised, the sunstone won't get [bright or] dark enough [when rotated]," he says. "So I think it would work, but not very accurately."

Also, Horváth and his team have yet to demonstrate that real sunstones – crystals mined in Scandinavia or Iceland – could detect the weak patterns under cloudy skies as well as their sensitive polarimeter can, which is something he is now investigating. If they do, Horváth will have compelling evidence that the Vikings possessed both the ways and the means to navigate under cloudy skies.

http://www.newscientist.com/article/dn20052-vikings-crystal-clear-method-of-navigation.html

Earliest Humans Not So Different from Us, Research Suggests



Artist's depiction of early humans. (Credit: iStockphoto)

ScienceDaily (Feb. 15, 2011) — That human evolution follows a progressive trajectory is one of the most deeply-entrenched assumptions about our species. This assumption is often expressed in popular media by showing cavemen speaking in grunts and monosyllables (the Geico Cavemen being a notable exception). But is this assumption correct? Were the earliest humans significantly different from us?

In a paper published in the latest issue of *Current Anthropology*, archaeologist John Shea (Stony Brook University) shows they were not.

The problem, Shea argues, is that archaeologists have been focusing on the wrong measurement of early human behavior. Archaeologists have been searching for evidence of "behavioral modernity," a quality supposedly unique to *Homo sapiens*, when they ought to have been investigating "behavioral variability," a quantitative dimension to the behavior of all living things.

Human origins research began in Europe, and the European Upper Paleolithic archaeological record has long been the standard against which the behavior of earlier and non-European humans is compared. During the Upper Paleolithic (45,000-12,000 years ago), *Homo sapiens* fossils first appear in Europe together with complex stone tool technology, carved bone tools, complex projectile weapons, advanced techniques for using fire, cave art, beads and other personal adornments. Similar behaviors are either universal or very nearly so among recent humans, and thus, archaeologists cite evidence for these behaviors as proof of human behavioral modernity.

Yet, the oldest *Homo sapiens* fossils occur between 100,000-200,000 years ago in Africa and southern Asia and in contexts lacking clear and consistent evidence for such behavioral modernity. For decades anthropologists contrasted these earlier "archaic" African and Asian humans with their "behaviorally-modern"

Upper Paleolithic counterparts, explaining the differences between them in terms of a single "Human Revolution" that fundamentally changed human biology and behavior. Archaeologists disagree about the causes, timing, pace, and characteristics of this revolution, but there is a consensus that the behavior of the earliest *Homo sapiens* was significantly that that of more-recent "modern" humans.

Shea tested the hypothesis that there were differences in behavioral variability between earlier and later *Homo sapiens* using stone tool evidence dating to between 250,000- 6000 years ago in eastern Africa. This region features the longest continuous archaeological record of *Homo sapiens* behavior. A systematic comparison of variability in stone tool making strategies over the last quarter-million years shows no single behavioral revolution in our species' evolutionary history. Instead, the evidence shows wide variability in *Homo sapiens* toolmaking strategies from the earliest times onwards. Particular changes in stone tool technology can be explained in terms of the varying costs and benefits of different toolmaking strategies, such as greater needs for cutting edge or more efficiently-transportable and functionally-versatile tools. One does not need to invoke a "human revolution" to account for these changes, they are explicable in terms of well-understood principles of behavioral ecology.

This study has important implications for archaeological research on human origins. Shea argues that comparing the behavior of our most ancient ancestors to Upper Paleolithic Europeans holistically and ranking them in terms of their "behavioral modernity" is a waste of time. There are no such things as modern humans, Shea argues, just *Homo sapiens* populations with a wide range of behavioral variability. Whether this range is significantly different from that of earlier and other hominin species remains to be discovered. However, the best way to advance our understanding of human behavior is by researching the sources of behavioral variability in particular adaptive strategies.

Story Source:

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

Journal Reference:

1. John J. Shea. **Homo sapiens is as Homo sapiens was: Behavioral variability vs. 'behavioral modernity' in Paleolithic archaeology**. *Current Anthropology*, 2011; 52 (1): 1 DOI: 10.1086/658067

http://www.sciencedaily.com/releases/2011/02/110214201850.htm

Jewel-Toned Organic Phosphorescent Crystals: A New Class of Light-Emitting Material

Organic phosphors developed at the University of Michigan could one day lead to cheaper organic light-emitting diodes. Here, they glow in blue and orange when triggered by ultraviolet light. (Credit: Marcin Szczepanski, U-M College of Engineering)

ScienceDaily (Feb. 15, 2011) — Pure organic compounds that glow in jewel tones could potentially lead to cheaper, more efficient and flexible display screens, among other applications.

University of Michigan researcher Jinsang Kim and his colleagues have developed a new class of material that shines with phosphorescence -- a property that has previously been seen only in non-organic compounds or organometallics.

Kim and his colleagues made metal-free organic crystals that are white in visible light and radiate blue, green, yellow and orange when triggered by ultraviolet light. By changing the materials' chemical composition, the researchers can make them emit different colors.

The new luminous materials, or phosphors, could improve upon current organic light-emitting diodes (OLEDs) and solid-state lighting. Bright, low-power OLEDs are used in some small screens on cell phones or cameras. At this time, they aren't practical for use in larger displays because of material costs and manufacturing issues.

The OLEDs of today aren't 100 percent organic, or made of carbon compounds. The organic materials used in them must be spiked with metal to get them to glow.

"Purely organic materials haven't been able to generate meaningful phosphorescence emissions. We believe this is the first example of an organic that can compete with an organometallic in terms of brightness and

color tuning capability," said Kim, an associate professor of materials science and engineering, chemical engineering, macromolecular science and engineering, and biomedical engineering.

This work is newly published online in *Nature Chemistry*.

The new phosphors exhibit "quantum yields" of 55 percent. Quantum yield, a measure of a material's efficiency and brightness, refers to how much energy an electron dissipates as light instead of heat as it descends from an excited state to a ground state. Current pure organic compounds have a yield of essentially zero.

In Kim's phosphors, the light comes from molecules of oxygen and carbon known as "aromatic carbonyls," compounds that produce phosphorescence, but weakly and under special circumstances such as extremely low temperatures. What's unique about these new materials is

that the aromatic carbonyls form strong halogen bonds with halogens in the crystal to pack the molecules tightly. This arrangement suppresses vibration and heat energy losses as the excited electrons fall back to the ground state, leading to strong phosphorescence.

"By combining aromatic carbonyls with tight halogen bonding, we achieve phosphorescence that is much brighter and in practical conditions," said Onas Bolton, a co-author of this paper who recently received his Ph.D. in Materials Science and Engineering.

This new method offers an easier way to make high-energy blue organic phosphors, which are difficult to achieve with organometallics.

Organic light emitting diodes are lighter and cheaper to manufacture than their non-organic counterparts, which are made primarily of ceramics. Today's OLEDs still contain small amounts of precious metals, though. These new compounds can bring the price down even further, because they don't require precious metals. They're made primarily of inexpensive carbon, oxygen, chlorine and bromine.

"This is in the beginning stage, but we expect that it will not be long before our simple materials will be available commercially for device applications," Kim said. "And we expect they will bring a big change in the LED and solid-state lighting industries because our compounds are very cheap and easy to synthesize and tune the chemical structure to achieve different colors and properties."

Former doctoral student Kangwon Lee discovered the unique properties of these materials while developing a biosensor -- a compound that detects biological molecules and can be used in medical testing and environmental monitoring. The phosphors have applications in this area as well. After Lee's discovery, Bolton developed the metal-free pure-organic phosphors.

The paper is titled "Activating efficient phosphorescence from purely-organic materials by crystal design." In addition to Kim, Bolton, and Lee, other contributors are: former postdoctoral researcher Hyong-Jun Kim in the Department of Materials Science and Engineering and recent Chemical Engineering graduate Kevin Y. Lin. This work is partly funded by the National Science Foundation and the National Research Foundation of Korea.

The university is pursuing patent protection for the intellectual property, and is seeking commercialization partners to help bring the technology to market.

Story Source:

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

Journal Reference:

1. Onas Bolton, Kangwon Lee, Hyong-Jun Kim, Kevin Y. Lin, Jinsang Kim. **Activating efficient phosphorescence from purely organic materials by crystal design**. *Nature Chemistry*, 2011; DOI: 10.1038/nchem.984

http://www.sciencedaily.com/releases/2011/02/110214122711.htm

World Phosphorous Use Crosses Critical Threshold

Algae collects on the surface water along the south shoreline of Lake Mendota near the University of Wisconsin-Madison on June 23, 2008. The algae blooms that occur in surface waters such as lakes and streams are fueled primarily by excess phosphorous, which runs off farm fields and suburban lawns. A new study by UW-Madison limnologist Stephen Carpenter recalculates global use of phosphorous and shows that the element's overuse is the primary cause of the pollution of fresh surface water. (Credit: Bryce Richter)

ScienceDaily (Feb. 14, 2011) — Recalculating the global use of phosphorous, a fertilizer linchpin of modern agriculture, a team of researchers warns that the world's stocks may soon be in short supply and that overuse in the industrialized world has become a leading cause of the pollution of lakes, rivers and streams.

Writing in the Feb. 14 edition of the journal *Environmental Research Letters*, Stephen Carpenter of the University of Wisconsin-Madison and Elena Bennett of McGill University report that the human use of phosphorous, primarily in the industrialized world, is causing the widespread eutrophication of fresh surface water. What's more, the minable global stocks of phosphorous are concentrated in just a few countries and are in decline, posing the risk of global shortages within the next 20 years.

"There is a finite amount of phosphorous in the world," says Carpenter, a UW-Madison professor of limnology and one of the world's leading authorities on lakes and streams. "This is a material that's becoming more rare and we need to use it more efficiently."

Phosphorous is an essential element for life. Living organisms, including humans, have small amounts and the element is crucial for driving the energetic processes of cells. In agriculture, phosphorous mined from ancient marine deposits is widely used to boost crop yields. The element also has other industrial uses.

But excess phosphorous from fertilizer that washes from farm fields and suburban lawns into lakes and streams is the primary cause of the algae blooms that throw freshwater ecosystems out of kilter and degrade water quality. Phosphorous pollution poses a risk to fish and other aquatic life as well as to the animals and humans who depend on clean fresh water. In some instances, excess phosphorous sparks blooms of toxic algae, which pose a direct threat to human and animal life.

"If you have too much phosphorous, you get eutrophication," explains Carpenter of the cycle of excessive plant and algae growth that significantly degrades bodies of fresh water. "Phosphorous stimulates the growth of algae and weeds near shore and some of the algae can contain cyanobacteria, which are toxic. You lose fish. You lose water quality for drinking."

The fertilizer-fueled algae blooms themselves amplify the problem as the algae die and release accumulated phosphorous back into the water.

Carpenter and Bennett write in their *Environmental Research Letters* report that the "planetary boundary for freshwater eutrophication has been crossed while potential boundaries for ocean anoxic events and depletion of phosphate rock reserves loom in the future."

Complicating the problem, says Carpenter, is the fact that excess phosphorous in the environment is a problem primarily in the industrialized world, mainly Europe, North America and parts of Asia. In other parts of the world, notably Africa and Australia, soils are phosphorous poor, creating a stark imbalance. Ironically, soils in places like North America, where fertilizers with phosphorous are most commonly applied, are already loaded with the element.

"Some soils have plenty of phosphorous, and some soils do not and you need to add phosphorous to grow crops on them," Carpenter notes. "It's this patchiness that makes the problem tricky."

Bennett and Carpenter argue that agricultural practices to better conserve phosphate within agricultural ecosystems are necessary to avert the widespread pollution of surface waters. Phosphorous from parts of the world where the element is abundant, they say, can be moved to phosphorous deficient regions of the world by extracting phosphorous from manure, for example, using manure digesters.

Deposits of phosphate, the form of the element that is mined for agriculture and other purposes, take many millions of years to form. The nations with the largest reserves of the element are the United States, China and Morocco.

The new study was supported by grants from the U.S. National Science Foundation and the Natural Sciences and Engineering Research Council of Canada.

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of Wisconsin-Madison**. The original article was written by Terry Devitt.

Journal Reference:

1. Stephen R Carpenter and Elena M Bennett. **Reconsideration of the planetary boundary for phosphorus**. *Environmental Research Letters*, 2011 DOI: 10.1088/1748-9326/6/1/014009

http://www.sciencedaily.com/releases/2011/02/110214163110.htm

Ancient Mesoamerican Sculpture Uncovered in Southern Mexico

This photo and drawing illustrate a recently discovered 3,000-year-old Olmec-style stone monument from Ojo de Agua, the site of an early planned settlement in what is now the southern Mexican state of Chiapas. The carved monument provides information about Olmec culture in the area and includes symbols of maize, deities or other important figures, and possible features of the natural world. (Credit: John Hodgson; Drawing: Kisslan Chan and John Clark, New World Archaeological Foundation)

ScienceDaily (Feb. 14, 2011) — With one arm raised and a determined scowl, the figure looks ready to march right off his carved tablet and into the history books. If only we knew who he was -- corn god? Tribal chief? Sacred priest?

"It's beautiful and was obviously very important," says University of Wisconsin-Madison archaeologist John Hodgson of the newly discovered stone monument. "But we will probably never know who he was or what the sculpture means in its entirety."

The man is the central figure on a stone monument discovered in 2009 at a site called Ojo de Agua in far southern Mexico in the state of Chiapas along the Pacific coast. Hodgson, a doctoral candidate in anthropology at UW-Madison, describes the new monument in the cover article of the current issue (December 2010) of *Mexicon*, a peer-reviewed journal of Mesoamerican studies. The article, titled "Ojo de Agua Monument 3: A New Olmec-Style Sculpture from Ojo de Agua, Chiapas, Mexico," is co-authored with John E. Clark, of Brigham Young University, and Emiliano Gallaga Murrieta, director of the National Institute of Anthropology and History in Chiapas.

Monument 3 is just the second carved monument found in Ojo de Agua. Monument 1 was discovered accidently when a local farmer hit it with a plow in the 1960s. Monument 3 was a similarly fortuitous finding, uncovered in the process of digging an irrigation ditch. (Monument 2 is a large boulder with a flat surface and no visible carving, which Hodgson found in 2005 and reported in the January/February 2006 issue of Archaeology magazine in an article on Ojo de Agua.)

Hodgson was working in the area and received word of the finding within just a few days of its discovery. He was able to see the monument's impression in the trench wall and study the soil layers where it had been buried, gaining a wealth of information that is usually lost long before any archaeologist lays eyes on a piece.

"Usually sculptures are first seen by archaeologists in private art collections and we normally have no good idea where they came from. The depictions of figures and the motifs change in form through time so you can get an approximate date by comparing styles," he says. "But we were able to date the new monument by where it was found to a narrow 100-year window, which is very rare."

The archaeological context and radiocarbon dating of ceramic sherds associated with the stone monument show that it dates to 1100 to 1000 B.C., making it approximately 3,000 years old. Its age and style correspond to the Early Formative period, when an early culture known as the Olmec dominated the area.

Its purpose and meaning, however, will be harder to ascertain.

"Everything means something in this kind of culture," says pre-eminent archaeologist Michael D. Coe, a professor emeritus of anthropology at Yale University and expert on Mesoamerican civilizations. "It obviously was a public monument -- an important one, probably in connection with some really big cheese who lorded it over the area." Coe was not directly involved in the work but is familiar with the newly discovered monument.

"It appears to me to be a depiction of an event or a way to convey other types of information," Hodgson adds. "This dates to a time prior to a developed written language, but like the modern symbol used internationally for the Red Cross, symbols are very efficient at communicating complicated ideas."

The main figure on the tablet is depicted wearing an elaborate headdress, loincloth and ornate accessories, including a pair of large, comb-like ear ornaments, a rope-like necklace and a thick belt with a jaguar-head buckle. A face on the headdress includes features such as sprouting plants that identify it as a corn god. The tablet also includes a smaller secondary figure and a series of asymmetric zigzag designs that the authors suggest could represent lightning, local mountain ranges, or other features of the natural world.

"This is closely connected with agriculture and the cult of the corn god," Coe says, pointing out the zigzags. "Thunderstorms bring the rain."

The monument is a carved flat slab of a relatively soft, local volcanic stone that weighs about 130 pounds. It stands nearly three feet tall, about 14 inches wide, and ranges from four to seven inches thick. The use of local materials shows it was made in or near Ojo de Agua, Hodgson says, but style similarities to pieces found in larger Olmec centers near the Gulf of Mexico and the Valley of Mexico indicate pan-regional influences as well.

"It's cruder in execution than most Olmec monuments from the other side of the isthmus -- 'provincial' Olmec," Coe says. But despite lacking some of the intricate artistry, it is still relatively sophisticated, he says. "This adds to our knowledge of the Olmec on the south side of the isthmus."

The depiction of corn is particularly notable. Corn cultivation is generally associated with a settled lifestyle rather than a nomadic existence, indicating that Ojo de Agua was almost certainly a farming community. The grain's storability and nutritional content also would have allowed the population to expand drastically and the civilization to become more complex, Hodgson says, adding that "the early date of the monument supports the idea that there was an early association between corn and religion."

Ojo de Agua lies in the heart of the ancient Aztec province Soconusco, nestled in a bend of the Coatán River. It is the earliest known site in Mesoamerica with formal pyramids built around plazas.

Though it has not been worked very extensively as an archeological site, Ojo de Agua appears to cover about 200 hectares and is the largest site in the area from the time period 1200-1000 B.C. The limited work to date

describes civic architecture consistent with a decent-sized planned settlement. The identified platform mounds are laid out in a deliberate alignment that may be relative to magnetic north.

"That's something we see later but to see it this early is pretty surprising," says Hodgson, who has been working at Ojo de Agua since 2003.

The site appears to have been occupied for 150 to 200 years before being abandoned for unknown reasons.

Hodgson expects there are many more clues at Ojo de Agua and hopes to have the opportunity to continue working at the site and perhaps another look at Monument 3.

"We've just scratched the surface there. The things we've found are fantastic," Hodgson says. "These early societies were a lot more complicated than we thought they were."

Hodgson's work has been supported by the New World Archaeological Foundation.

Story Source:

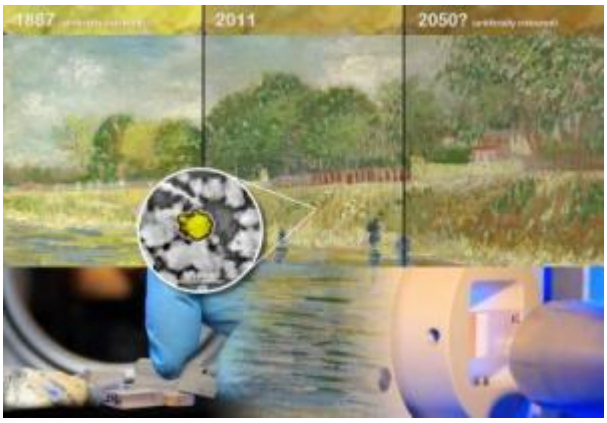
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of Wisconsin-Madison**.

Journal Reference:

1. John Hodgson, John E. Clark, and Emiliano Gallaga Murrieta. **Ojo de Agua Monument 3: A New Olmec-Style Sculpture from Ojo de Agua, Chiapas, Mexico**. *Mexicon*, Volume XXXII, No. 6, December 2010 [link]

http://www.sciencedaily.com/releases/2011/02/110214163102.htm

X-Rays Show Why Van Gogh Paintings Lose Their Shine



This illustration shows how X-Rays were used to study why van Gogh paintings lose their shine. Top: a photo of the painting "Bank of the River Seine" on display at the van Gogh Museum, divided in three and artificially colored to simulate a possible state in 1887 and 2050. Bottom left: microscopic samples from art masterpieces moulded in plexiglass blocks. The tube with yellow chrome paint is from the personal collection of M. Cotte. Bottom right: X-ray microscope set-up at the ESRF with a sample block ready for a scan. Centre: an image made using a high-resolution, analytical electron microscope to show affected pigment grains from the van Gogh painting, and how the color at their surface has changed due to reduction of chromium. The scale bar indicates the size of these pigments. (Credit: ESRF/Antwerp University/Van Gogh Museum)

ScienceDaily (Feb. 14, 2011) — Scientists have identified a complex chemical reaction responsible for the degradation of two paintings by Vincent van Gogh and other artists of the late 19th century. This discovery is a first step to understanding how to stop the bright yellow colours of van Gogh's most famous paintings from being covered by a brown shade, and fading over time. In the meantime, the results suggest shielding affected paintings as much as possible from UV and sunlight.

The results are published in the 15 February 2011 issue of *Analytical Chemistry*.

The work was carried out by an international team of scientists from four countries led by Koen Janssens of Antwerp University (Belgium), with Letizia Monico, an Italian chemist preparing a Ph.D. at Perugia University (Italy), taking the centre stage in the experiments. As an Erasmus student, she worked for one year in Janssens' research group in Antwerp, and is also the lead author of the two papers. Scientists from the CNR Institute of Molecular Science and Technologies (Perugia, Italy), the CNRS C2RMF (Paris, France), TU Delft (Netherlands) and the van Gogh Museum (Amsterdam, Netherlands) were also part of the team.

Uncovering the secrets of the chemical reaction needed deployment of an impressive arsenal of analytical tools, with synchrotron X-rays at the ESRF in Grenoble (France) providing the final answers. "For every Italian, conservation of masterpieces has always mattered. I am pleased that science has now added a piece to a puzzle that is a big headache for so many museums" says Letizia Monico from University of Perugia.

The experiment reads like a crime scene investigation. The scientists employed an X-ray beam of microscopic dimensions to reveal a complex chemical reaction taking place in the incredibly thin layer where the paint meets the varnish. Sunlight can penetrate only a few micrometers into the paint, but over this short distance, it will trigger a hitherto unknown chemical reaction turning chrome yellow into brown pigments, altering the original composition.

Van Gogh's decision to use novel bright colours in his paintings is a major milestone in the history of art. He deliberately chose colours that conveyed mood and emotion, rather than employing them realistically. At the

time, this was completely unheard of and, without major innovations in pigment manufacturing made in the 19th century, would also have been impossible.

It was the vibrancy of new industrial pigments such as chrome yellow which allowed van Gogh to achieve the intensity of, for example, his series of Sunflowers paintings. He started to paint in these bright colours after leaving his native Holland for France where he became friends with artists who shared his new ideas about the use of colours. For one of them, Paul Gauguin, he started painting yellow sunflower motifs as a decoration for his bedroom.

The fact that yellow chrome paint darkens under sunlight has been known since the early 19th Century. However, not all period paintings are affected, nor does it always happen at the same speed. As chrome yellow is toxic, artists quickly switched to new alternatives in the 1950s. However, Vincent van Gogh did not have this choice, and to preserve his work and that of many comtemporaries, interest in the darkening of chrome yellow is now rising again.

To solve a chemical puzzle nearly 200 years old, the team around Janssens used a two-step approach: first, they collected samples from three left-over historic paint tubes. After these samples had been artificially aged for 500 hours using an UV-lamp, only one sample, from a paint tube belonging to the Flemish Fauvist Rik Wouters (1882-1913), showed significant darkening. Within 3 weeks, its surface of originally bright yellow had become chocolate brown. This sample was taken as the best candidate for having undergone the fatal chemical reaction, and sophisticated X-ray analysis identified the darkening of the top layer as linked to a reduction of the chromium in the chrome yellow from Cr(VI) to Cr(III). The scientists also reproduced Wouters' chrome yellow paint and found that the darkening effect could be provoked by UV light.

In the second step, the scientists used the same methods to examine samples from affected areas of two van Gogh paintings, View of Arles with Irises (1888) and Bank of the Seine (1887), both on display in the Van Gogh Museum in Amsterdam.

"This type of cutting edge research is crucial to advance our understanding of how paintings age and should be conserved for future generations," says Ella Hendriks of the van Gogh Museum Amsterdam.

Because the affected areas in these multicoloured samples were even more difficult to locate than in the artificially aged ones, an impressive array of analytical tools had to be deployed which required the samples travelling to laboratories across Europe. The results indicate that the reduction reaction from Cr(VI) to Cr(III) is likely to also have taken place in the two van Gogh paintings.

The microscopic X-ray beam also showed that Cr(III) was especially prominent in the presence of chemical compounds which contained barium and sulphur. Based on this observation, the scientists speculate that van Gogh's technique of blending white and yellow paint might be the cause of the darkening of his yellow paint.

"Our next experiments are already in the pipeline. Obviously, we want to understand which conditions favour the reduction of chromium, and whether there is any hope to revert pigments to the original state in paintings where it is already taking place.," summarises Koen Janssens from University of Antwerp.

The techniques used by the scientists included X-ray diffraction along with various spectroscopies employing infrared radiation, electrons and X-rays at the universities of Antwerp and Perugia, and at two synchrotrons (ESRF and DESY).

"I am not aware of a similarly big effort ever having been made for the chemistry of an oil painting," says Joris Dik, Professor at Delft Technical University.

In the decisive step, two techniques were combined using a single X-ray beam at the ESRF: X-Ray fluorescence (XRF) and X-Ray absorption near-edge spectroscopy (XANES). For the XRF, the microscopic beam size (0.9 x 0.25 μm²) made possible to separate the study of degraded and unaffected areas, and the XANES technique proved the speciation of chromium, i.e. the reduction from Cr(VI) to Cr(III).

"Our X-ray beam is one hundred times thinner than a human hair, and it reveals subtle chemical processes over equally minuscule areas. Making this possible has opened the door to a whole new world of discovery for art historians and conservators," says Marine Cotte, an ESRF scientist also working at CNRS/Musée du Louvre.

The reduction of chromium that had been observed in the artificially aged sample from the atelier of Rik Wouters was finally confirmed in both microsamples from the van Gogh paintings.

The study was completed with a nanoscopic investigation of the discoloured paint using electron energy loss spectroscopy at the University of Antwerp, which confirmed the results and showed that the newly formed Cr(III) compounds were formed as a nanometer-thin coating of the pigment particles that constitute the paint.

Story Source:

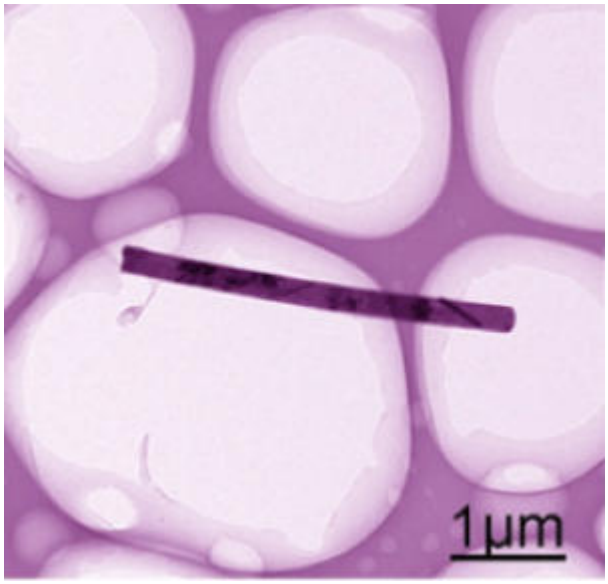
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **European Synchrotron Radiation Facility**.

Journal Reference:

1. Letizia Monico, Geert Van der Snickt, Koen Janssens, Wout De Nolf, Costanza Miliani, Joris Dik, Marie Radepont, Ella Hendriks, Muriel Geldof, Marine Cotte. **Degradation Process of Lead Chromate in Paintings by Vincent van Gogh Studied by Means of Synchrotron X-ray Spectromicroscopy and Related Methods. 2. Original Paint Layer Samples**. *Analytical Chemistry*, 2011; 83 (4): 1224 DOI: 10.1021/ac1025122

http://www.sciencedaily.com/releases/2011/02/110214142340.htm

Next-Generation Electronic Devices: Conduction, Surface States in Topological Insulator Nanoribbons Controlled



Bismuth telluride nanoribbon crystalline structure. (Credit: Image courtesy of University of California - Los Angeles)

ScienceDaily (Feb. 14, 2011) — In recent years, topological insulators have become one of the hottest topics in physics. These new materials act as both insulators and conductors, with their interior preventing the flow of electrical currents while their edges or surfaces allow the movement of a charge.

Perhaps most importantly, the surfaces of topological insulators enable the transport of spin-polarized electrons while preventing the "scattering" typically associated with power consumption, in which electrons deviate from their trajectory, resulting in dissipation.

Because of such characteristics, these materials hold great potential for use in future transistors, memory devices and magnetic sensors that are highly energy efficient and require less power.

In a study published Feb. 13 in *Nature Nanotechnology*, researchers from UCLA's Henry Samueli School of Engineering and Applied Science and from the materials division of Australia's University of Queensland show the promise of surface-conduction channels in topological insulator nanoribbons made of bismuth telluride and demonstrate that surface states in these nanoribbons are "tunable" -- able to be turned on and off depending on the position of the Fermi level.

"Our finding enables a variety of opportunities in building potential new-generation, low-dissipation nanoelectronic and spintronic devices, from magnetic sensing to storage," said Kang L. Wang, the Raytheon Professor of Electrical Engineering at UCLA Engineering, whose team carried out the research.

Bismuth telluride is well known as a thermoelectric material and has also been predicted to be a three-dimensional topological insulator with robust and unique surface states. Recent experiments with bismuth telluride bulk materials have also suggested two-dimensional conduction channels originating from the surface states. But it has been a great challenge to modify surface conduction, because of dominant bulk contribution due to impurities and thermal excitations in such small-band-gap semiconductors.

The development of topological insulator nanoribbons has helped. With their large surface-to-volume ratios, these nanoribbons significantly enhance surface conditions and enable surface manipulation by external means.

Wang and his team used thin bismuth telluride nanoribbons as conducting channels in field-effect transistor structures. These rely on an electric field to control the Fermi level and hence the conductivity of a channel. The researchers were able to demonstrate for the first time the possibility of controlling surface states in topological insulator nanostructures.

"We have demonstrated a clear surface conduction by partially removing the bulk conduction using an external electric field," said Faxian Xiu, a UCLA staff research associate and lead author of the study. "By properly tuning the gate voltage, very high surface conduction was achieved, up to 51 percent, which represents the highest values in topological insulators."

"This research is very exciting because of the possibility to build nanodevices with a novel operating principle," said Wang, who is also associate director of the California NanoSystems Institute (CNSI) at UCLA. "Very similar to the development of graphene, the topological insulators could be made into high-speed transistors and ultra-high-sensitivity sensors."

The new findings shed light on the controllability of the surface spin states in topological insulator nanoribbons and demonstrate significant progress toward high surface electric conditions for practical device applications. The next step for Wang's team is to produce high-speed devices based on their discovery.

"The ideal scenario is to achieve 100 percent surface conduction with a complete insulating state in the bulk," Xiu said. "Based on the current work, we are targeting high-performance transistors with power consumption that is much less than the conventional complementary metal-oxide semiconductors (CMOS) technology used typically in today's electronics."

Study collaborators Jin Zou, a professor of materials engineering at the University of Queensland; Yong Wang, a Queensland International Fellow; and Zou's team at the division of materials at the University of Queensland contributed significantly to this work. A portion of the research was also done in Alexandros Shailos' lab at UCLA.

The study was funded by the Focus Center Research Program -- Center on Functional Engineered Nano Architectonics (FENA) at UCLA Engineering; the U.S. Defense Advanced Research Projects Agency (DARPA); and the Australian Research Council. The research on topological insulators was pioneered by FENA's Shoucheng Zhang, a professor of physics at Stanford University.

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of California - Los Angeles**. The original article was written by Wileen Wong Kromhout.

Journal Reference:

1. Faxian Xiu, Liang He, Yong Wang, Lina Cheng, Li-Te Chang, Murong Lang, Guan Huang, Xufeng Kou, Yi Zhou, Xiaowei Jiang, Zhigang Chen, Jin Zou, Alexandros Shailos, Kang L. Wang. **Manipulating surface states in topological insulator nanoribbons**. *Nature Nanotechnology*, 2011; DOI: 10.1038/nnano.2011.19

http://www.sciencedaily.com/releases/2011/02/110214142346.htm

Mummy Remains Show False Toes Helped Ancient Egyptians Walk

The original toe held at the Egyptian Museum in Cairo. (Credit: Image courtesy of University of Manchester)

ScienceDaily (Feb. 14, 2011) — Two artificial big toes -- one found attached to the foot of an ancient Egyptian mummy -- may have been the world's earliest functional prosthetic body parts, says the scientist who tested replicas on volunteers.

University of Manchester researcher, Dr Jacky Finch, has shown that a three-part wood and leather artefact housed in the Egyptian Museum in Cairo, along with a second one, the Greville Chester artificial toe on display in the British Museum, not only looked the part but also helped their toeless owners walk like Egyptians.

The toes date from before 600BC, predating what was hitherto thought to be the earliest known practical prosthesis -- the Roman Capula Leg -- by several hundred years.

Dr Finch, who is based in the University of Manchester's KNH Centre for Biomedical Egyptology, recruited two volunteers whose right big toe had been lost in order to test exact replicas of the artificial toes in the Gait Laboratory at Salford University's Centre for Rehabilitation and Human Performance Research.

Writing in the *Lancet*, Dr Finch said: "To be classed as true prosthetic devices any replacement must satisfy several criteria. The material must withstand bodily forces so that it does not snap or crack with use. Proportion is important and the appearance must be sufficiently lifelike as to be acceptable to both the wearer and those around them. The stump must also be kept clean, so it must be easy to take on and off. But most importantly it must assist walking.

She continued: "The big toe is thought to carry some 40% of the bodyweight and is responsible for forward propulsion, although those without it can adapt well. To accurately determine any level of function requires the application of gait analysis techniques involving integrated cameras and pressure devices placed along a walkway."

The volunteers were asked to wear the toes with replica Egyptian sandals and, while neither design was expected to perform exactly like a real big toe, one of the volunteers was able to walk extremely well with both artificial toes. No significant elevation in pressure under the foot was recorded for either toe, although both volunteers said they found the Cairo toe particularly comfortable.

The Greville Chester toe -- made from cartonnage, a sort of papier maché made using linen, glue and plaster -- shows considerable signs of wear, while the Cairo toe has certain features, such as a simple hinge, a chamfered front edge and a flattened underside.

"The wear on the Greville Chester toe and the important design features on the Cairo toe led me to speculate that these toes were perhaps worn by their owners in life and not simply attached to the foot during mummification for religious or ritualistic reasons," said Dr Finch.

"However, until we were able to test replicas of both toes using volunteers under laboratory conditions, it remained uncertain if they could indeed help their owners to walk.

"My findings strongly suggest that both of these designs were capable of functioning as replacements for the lost toe and so could indeed be classed as prosthetic devices. If that is the case then it would appear that the first glimmers of this branch of medicine should be firmly laid at the feet of the ancient Egyptians."

Story Source:

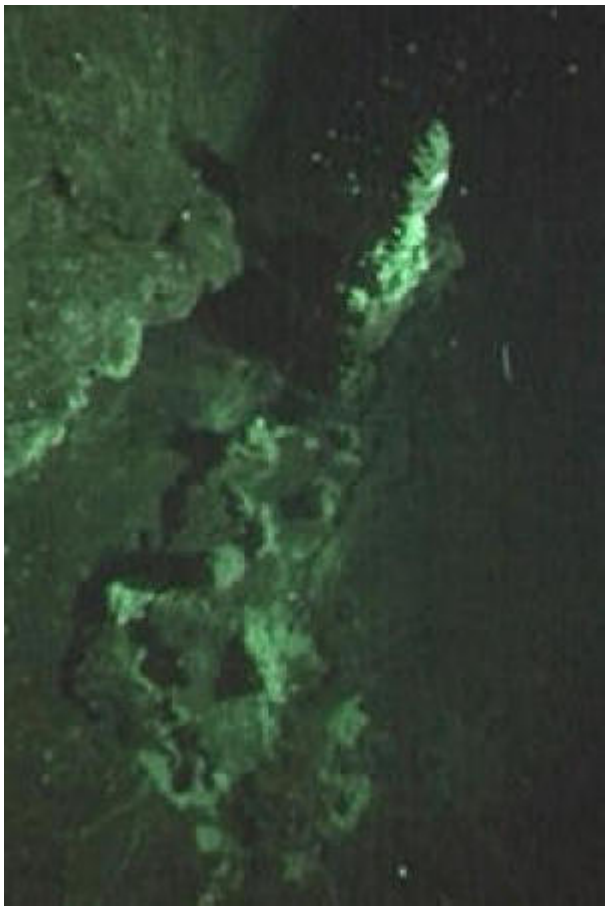
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of Manchester**, via AlphaGalileo.

Journal Reference:

1. Jacqueline Finch. **The ancient origins of prosthetic medicine**. *The Lancet*, 2011; 377 (9765): 548 DOI: 10.1016/S0140-6736(11)60190-6

http://www.sciencedaily.com/releases/2011/02/110213192335.htm

Deep-Sea Volcanic Vents Discovered in Chilly Waters of Southern Ocean



One of the newly discovered vents. (Credit: Image courtesy of National Oceanography Centre, Southampton (UK))

ScienceDaily (Feb. 14, 2011) — Scientists aboard the Royal Research Ship *James Cook* have discovered a new set of deep-sea volcanic vents in the chilly waters of the Southern Ocean. The discovery is the fourth made by the research team in three years, which suggests that deep-sea vents may be more common in our oceans than previously thought.

Using an underwater camera system, the researchers saw slender mineral spires three metres tall, with shimmering hot water gushing from their peaks, and gossamer-like white mats of bacteria coating their sides. The vents are at a depth of 520 metres in a newly-discovered seafloor crater close to the South Sandwich Islands, a remote group of islands around 500 kilometres south-east of South Georgia.

"When we caught the first glimpse of the vents, the excitement was almost overwhelming," says Leigh Marsh, a University of Southampton PhD student who was on scientific watch at the time of the discovery.

Deep-sea vents are hot springs on the seafloor, where mineral-rich water nourishes lush colonies of microbes and deep-sea animals. In the three decades since scientists first encountered vents in the Pacific, around 250

have been discovered worldwide. Most have been found on a chain of undersea volcanoes called the mid-ocean ridge, however, and very few are known in the Antarctic.

"We're finding deep-sea vents more rapidly than ever before," says expedition leader Professor Paul Tyler of the University of Southampton's School of Ocean and Earth Science, which is based at the National Oceanography Centre, Southampton. "And we're finding some in places other than at mid-ocean ridges, where most have been seen before."

By studying the new vents, the team hope to understand more about the distribution and evolution of life in the deep ocean, the role that deep-sea vents play in controlling the chemistry of the oceans, and the diversity of microbes that thrive in different conditions beneath the waves.

The researchers were exploring 'Adventure Caldera', a crater-like hole in the seafloor three kilometres across and 750 metres deep at its deepest point. Despite its size, Adventure Caldera was only discovered last year by geophysicists from the British Antarctic Survey.

The new vents are the fourth set to be discovered around Antarctica in three expeditions since 2009. Their discovery is part of a project funded by the UK Natural Environment Research Council (NERC), which involves researchers from the National Oceanography Centre in Southampton, the British Antarctic Survey in Cambridge, the Universities of Southampton, Newcastle, Oxford, Bristol and Leeds, and Woods Hole Oceanographic Institution in the US.

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **National Oceanography Centre, Southampton (UK)**.

http://www.sciencedaily.com/releases/2011/02/110214115438.htm

Massive Flux of Gas, in Addition to Liquid Oil, at BP Well Blowout in Gulf

An oil boom positioned to protect wetlands from the 2010 Gulf Oil Spill. (Credit: iStockphoto/Chad Purser)

ScienceDaily (Feb. 14, 2011) — A new University of Georgia study that is the first to examine comprehensively the magnitude of hydrocarbon gases released during the Deepwater Horizon Gulf of Mexico oil discharge has found that up to 500,000 tons of gaseous hydrocarbons were emitted into the deep ocean. The authors conclude that such a large gas discharge -- which generated concentrations 75,000 times the norm -- could result in small-scale zones of "extensive and persistent depletion of oxygen" as microbial processes degrade the gaseous hydrocarbons.

The study, led by UGA Professor of Marine Sciences Samantha Joye, appears in the early online edition of the journal *Nature Geoscience*. Her co-authors are Ian MacDonald of Florida State University, Ira Leifer of the University of California-Santa Barbara and Vernon Asper of the University of Southern Mississippi.

The Macondo Well blowout discharged not only liquid oil, but also hydrocarbon gases, such as methane and pentane, which were deposited in the water column. Gases are normally not quantified for oil spills, but the researchers note that in this instance, documenting the amount of hydrocarbon gases released by the blowout is critical to understanding the discharge's true extent, the fate of the released hydrocarbons, and potential impacts on the deep oceanic systems. The researchers explained that the 1,480-meter depth of the blowout (nearly one mile) is highly significant because deep sea processes (high pressure, low temperature) entrapped the released gaseous hydrocarbons in a deep (1,000-1,300m) layer of the water column. In the supplementary online materials, the researchers provide high-definition photographic evidence of the oil and ice-like gas hydrate flakes in the plume waters.

Joye said the methane and other gases likely will remain deep in the water column and be consumed by microbes in a process known as oxidation, which en masse can lead to low-oxygen waters.

"We're not talking about extensive hypoxic areas offshore in the Gulf of Mexico," Joye explained. "But the microbial oxidation of the methane and other alkanes will remove oxygen from the system for quite a while because the time-scale for the replenishment of oxygen at that depth is many decades."

Leifer added that some of the larger gaseous hydrocarbons documented, such as pentane, have significant health implications for humans and potentially for marine life.

The study concludes that separating the gas-induced oxygen depletion from that due to liquid hydrocarbons is difficult, absent further research, because all hydrocarbons contribute to oxygen depletion. Therefore,

documenting the total mass of hydrocarbons discharged is critical for understanding the long-term implications for the Gulf's microbial communities, food chain and overall system.

Joye's team examined samples from 70 sites around the leaking wellhead during a research cruise aboard the R/V Walton Smith during late May and early June of 2010. They combined their data with estimates of the volume of oil released to arrive at a figure that allows scientists to quantify, for the first time, the gas discharge in terms of equivalent barrels of oil. They calculated a gas discharge that's the equivalent of either 1.6 to 1.9 or 2.2 to 3.1 million barrels of oil, depending on the method used. Although the estimate reflects the uncertainty still surrounding the discharge, even the lowest magnitude represents a significant increase in the total hydrocarbon discharge.

"These calculations increase the accepted government estimates by about one third," MacDonald said.

The ever-shifting small-scale currents in the Gulf likely have dissipated the plumes and the low oxygen zones associated with them, Joye said, making them difficult if not impossible to find at this point in time. Although gliders are a new platform being used, scientists typically search for subsurface features by dropping instruments from research vessels, a process that's analogous to looking for a feature on Earth's surface by randomly dropping instruments from a height of 1,500 meters (about 5,000 feet) in the atmosphere.

"It's like searching for a needle in the haystack," Joye said. "We may never know what happened to all of that gas."

Joye cautioned against assuming that microbes will rapidly consume the gases released from the well. Undoubtedly, the methane is a feast for them, Joye said, but she also noted that the microbes need nutrients, such as nitrogen, copper and iron. These nutrients are in scarce supply in the Gulf's deep waters, Joye said, and once they are depleted the microbes will cease to grow -- regardless of how much methane is available.

"This study highlights the value of knowledge gained from deep sea hydrate seepage research but also how poorly deep sea processes are understood, such as the role methane hydrates played in forming the deep methane plumes documented by this study," Leifer said. "Deepwater Horizon underscored how ill-prepared the nation is to respond to future accidents. As a nation, we need to hear this deep sea Sputnik wake-up call."

The research was supported by the National Science Foundation and the National Oceanic and Atmospheric Administration National Institute for Undersea Technology.

Story Source:

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

Journal Reference:

1. Samantha B. Joye, Ian R. MacDonald, Ira Leifer, Vernon Asper. **Magnitude and oxidation potential of hydrocarbon gases released from the BP oil well blowout**. *Nature Geoscience*, 2011; DOI: 10.1038/ngeo1067

http://www.sciencedaily.com/releases/2011/02/110213162733.htm

Lost Whaling Shipwreck With Link to Melville's Moby-Dick Discovered in the Northwestern Hawaiian Islands

A diver examines an anchor at the Two Brothers shipwreck site. (Credit: NOAA)

ScienceDaily (Feb. 14, 2011) — Maritime heritage archaeologists working with NOAA's Office of National Marine Sanctuaries have found the nationally-significant wreckage of a famous 1800's Nantucket whale ship, *Two Brothers,* on a reef off French Frigate Shoals, nearly six hundred miles northwest of Honolulu, in the remote Papahānaumokuākea Marine National Monument.

This rare archaeological discovery is the first discovery of a wrecked whaling ship from Nantucket, Mass., the birthplace of America's whaling industry. All of America's whaling ships are now gone, broken up or sunk, except one, the National Historic Landmark *Charles W. Morgan* at Mystic Seaport Museum in Connecticut.

Two Brothers was captained by George Pollard Jr., whose previous Nantucket whaling vessel, *Essex,* was rammed and sunk by a whale in the South Pacific, inspiring Herman Melville's famous book, *Moby-Dick.* Pollard gained national notoriety after the *Essex* sinking, when he and a handful of his crew resorted to cannibalism in order to survive their prolonged ordeal drifting on the open ocean. The story of Pollard, *Essex* and *Two Brothers* was reintroduced to American audiences by author Nathaniel Philbrick's New York Times bestseller, *In the Heart of the Sea*.

Capt. Pollard went to sea again as the Master of *Two Brothers* and was likely the last person to think "lightning would strike twice," but it did on the night of Feb. 11, 1823, when *Two Brothers* hit a shallow reef off French Frigate Shoals. Pollard did not want to abandon ship but his crew pleaded with him and they clung to small boats for survival during a long and harrowing night. The next morning they were rescued by the crew of another Nantucket whaler.

For the past 188 years, the wreckage of *Two Brothers* has been lost on the ocean floor. The vessel was part of a fleet of several hundred whaling ships that were part of America's economic and political expansion into the

Pacific, transforming the region, including Hawaii, both economically and culturally, and resulting in the near extinction of many whale species. The whaling fleets were also largely responsible for early exploration of the Indian Ocean and the polar regions.

A 2008 NOAA-led expedition to the Northwestern Hawaiian Islands to study marine life, remove floating marine debris and look for cultural resources resulted in the initial clues about the resting place of the *Two Brothers.* Maritime archaeologists first spotted a large anchor, followed by three trypots (cast iron pots for melting whale blubber to produce oil), another large anchor, hundreds of bricks and the remains of the ship's rigging. Those artifacts conclusively indicated the wreckage was from a whaler dating to the early 19th century. Subsequent expeditions in 2009 and 2010 resulted in researchers discovering more artifacts including blubber hooks, five whaling harpoon tips, three whaling lances, four cast-iron cooking pots and ceramics and glass indicating a U.S. origin. This helped confirm the dating of the wreckage. Additional scholarly research provided first-hand accounts from *Two Brothers* crew members, including an approximate location of where the ship grounded, which matched the location of the wreckage.

"Shipwreck sites like this are important in helping tell the stories of the early days of sailing, including whaling and maritime activities both in the Pacific and around the world," said Papahānaumokuākea Marine National Monument maritime archaeologist Kelly Gleason, Ph.D., who led the on-site expeditions using NOAA Ship *Hi'ialakai.*

"Discoveries like the *Two Brothers* serve an important role in connecting geographically separated regions and communities (New England and the Pacific), the past to the present, and provide context and better understanding human decisions that have altered the planet," said James Delgado, director, NOAA's Office of National Marine Sanctuaries' Maritime Heritage Program.

Papahānaumokuākea is cooperatively managed to ensure ecological integrity and achieve strong, long-term protection and perpetuation of Northwestern Hawaiian Island ecosystems, Native Hawaiian culture, and heritage resources for current and future generations. Three co-trustees -- the Department of Commerce, Department of the Interior and State of Hawai'i, joined by the Office of Hawaiian Affairs -- protect this special place. Papahānaumokuākea Marine National Monument was designated as the first mixed (natural and cultural) UNESCO World Heritage Site in the United States in July 2010. Downloadable images ofshipwreck artifacts, a site map and artist renderings of whaleship *Essex* are available at http://www.papahanaumokuakea.gov/maritime/twobrothersmedia.html

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Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **National Oceanic and Atmospheric Administration**.

http://www.sciencedaily.com/releases/2011/02/110213212230.htm

Physicists Isolate Bound States in Graphene-Superconductor Junctions

Illinois physics professor Nadya Mason led a team that isolated unique electron bound states that form in graphene-superconductor junctions. (Credit: Ivan Petrov)

ScienceDaily (Feb. 15, 2011) — Illinois researchers have documented the first observations of some unusual physics when two prominent electric materials are connected: superconductors and graphene.

Led by University of Illinois physics professor Nadya Mason, the group published its findings in the journal *Nature Physics.*

When a current is applied to a normal conductor, such as metal or graphene, it flows through the material as a stream of single electrons. By contrast, electrons travel in pairs in superconductors. Yet when a normal material is sandwiched between superconductors, the normal metal can carry the supercurrent.

Normal metals can adopt superconducting capacity because the paired electrons from the superconductor are translated to special electron-hole pairs in the normal metal, called Andreev bound states (ABS).

"If you have two superconductors with a normal metal between, you can actually transport the superconductivity across the normal material via these bound states, even though the normal material doesn't have the electron pairing that the superconductors do," Mason said.

ABS are extremely difficult to measure or to observe directly. Researchers can measure conduction and overall magnitude of a current, but have not been able to study individual ABS to understand the fundamental physics contributing to these unique states.

Mason's group developed a method of isolating individual ABS by connecting superconducting probes to tiny, nanoscale flakes of graphene called quantum dots. This confined the ABS to discrete energy levels within the quantum dot, allowing the researchers to measure the superconducting ABS individually and even to manipulate them.

"Before this, it wasn't really possible to understand the fundamentals of what is transporting the current," Mason said. "Watching an individual bound state allows you to change one parameter and see how one mode changes. You can really get at a systematic understanding. It also allows you to manipulate ABS to use them for different things that just couldn't be done before."

Superconductor junctions have been proposed for use as superconducting transistors or bits for quantum computers, called qubits. Greater understanding of ABS may enable other applications as well. In addition, it may be possible to use the superconducting graphene quantum dots themselves as solid-state qubits.

"This is a unique case where we found something that we couldn't have discovered without using all of these different elements -- without the graphene, or the superconductor, or the quantum dot, it wouldn't have worked. All of these are really necessary to see this unusual state," Mason said.

The U.S. Department of Energy supported this work, conducted at the Frederick Seitz Materials Research Laboratory at Illinois.

Story Source:

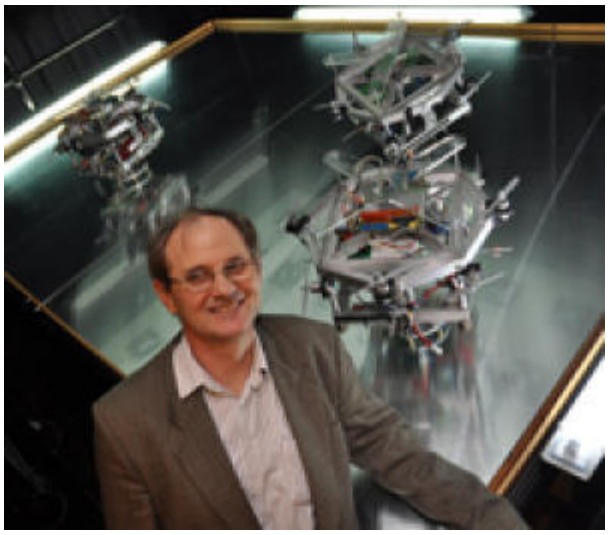
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of Illinois at Urbana-Champaign**.

Journal Reference:

1. Travis Dirks, Taylor L. Hughes, Siddhartha Lal, Bruno Uchoa, Yung-Fu Chen, Cesar Chialvo, Paul M. Goldbart, Nadya Mason. **Transport through Andreev bound states in a graphene quantum dot**. *Nature Physics*, 2011; DOI: 10.1038/nphys1911

http://www.sciencedaily.com/releases/2011/02/110214142348.htm

Scientists Develop Control System to Allow Spacecraft to Think for Themselves



The attached image shows Professor Veres with a satellite model at the University's unique test facility. (Credit: Image courtesy of University of Southampton)

ScienceDaily (Feb. 15, 2011) — The world's first control system that will allow engineers to programme satellites and spacecraft to think for themselves has been developed by scientists from the University of Southampton.

Professor Sandor Veres and his team of engineers have developed an artificially intelligent control system called 'sysbrain'.

Using natural language programming (NLP), the software agents can read special English language technical documents on control methods. This gives the vehicles advanced guidance, navigation and feedback capabilities to stop them crashing into other objects and the ability to adapt during missions, identify problems, carry out repairs and make their own decisions about how best to carry out a task.

Professor Veres, who is leading the EPSRC-funded project, says: "This is the world's first publishing system of technical knowledge for machines and opens the way for engineers to publish control instructions to machines directly. As well as spacecrafts and satellites, this innovative technology is transferable to other types of autonomous vehicles, such as autonomous underwater, ground and aerial vehicles."

To test the control systems that could be applied in a space environment, Professor Veres and his team constructed a unique test facility and a fleet of satellite models, which are controlled by the sysbrain cognitive agent control system.

The 'Autonomous Systems Testbed' consists of a glass covered precision level table, surrounded by a metal framework, which is used to mount overhead visual markers, observation cameras and isolation curtains to prevent any external light sources interfering with experimentation. Visual navigation is performed using onboard cameras to observe the overhead marker system located above the test area. This replicates how spacecraft would use points in the solar system to determine their orientation.

The perfectly-balanced model satellites, which rotate around a pivot point with mechanical properties similar to real satellites, are placed on the table and glide across it on roller bearings almost without friction to mimic the zero-gravity properties of space. Each model has eight propellers to control movement, a set of inertia

sensors and additional cameras to be 'spatially aware' and to 'see' each other. The model's skeletal robot frame also allows various forms of hardware to be fitted and experimented with.

Professor Veres adds: "We have invented sysbrains to control intelligent machines. Sysbrain is a special breed of software agents with unique features such as natural language programming to create them, human-like reasoning, and most importantly they can read special English language documents in 'system English' or 'sEnglish'. Human authors of sEnglish documents can put them on the web as publications and sysbrain can read them to enhance their physical and problem solving skills. This allows engineers to write technical papers directly for sysbrain that control the machines."

Further information is available at http://www.sesnet.soton.ac.uk/people/smv/avs_lab/index.htm.

Story Source:

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

http://www.sciencedaily.com/releases/2011/02/110214083813.htm

Don't Blame the Pill for Estrogen in Drinking Water

Birth control pills. Contrary to popular belief, birth control pills account for less than 1 percent of the estrogens found in the nation's drinking water supplies, scientists have concluded in an analysis of studies published on the topic. (Credit: iStockphoto/Stefan Redel)

ScienceDaily (Feb. 15, 2011) — Contrary to popular belief, birth control pills account for less than 1 percent of the estrogens found in the nation's drinking water supplies, scientists have concluded in an analysis of studies published on the topic. Their report suggests that most of the sex hormone -- source of concern as an endocrine disruptor with possible adverse effects on people and wildlife -- enters drinking water supplies from other sources. The report appears in ACS' journal *Environmental Science & Technology*.

Amber Wise, Kacie O'Brien and Tracey Woodruff note ongoing concern about possible links between chronic exposure to estrogens in the water supply and fertility problems and other adverse human health effects. Almost 12 million women of reproductive age in the United States take the pill, and their urine contains the hormone. Hence, the belief that oral contraceptives are the major source of estrogen in lakes, rivers, and streams. Knowing that sewage treatment plants remove virtually all of the main estrogen -- 17 alpha-ethinylestradiol (EE2) -- in oral contraceptives, the scientists decided to pin down the main sources of estrogens in water supplies.

Their analysis found that EE2 has a lower predicted concentration in U.S. drinking water than natural estrogens from soy and dairy products and animal waste used untreated as a farm fertilizer. And that all humans, (men, women and children, and especially pregnant women) excrete hormones in their urine, not just women taking the pill. Some research cited in the report suggests that animal manure accounts for 90 percent of estrogens in the environment. Other research estimates that if just 1 percent of the estrogens in livestock waste reached waterways, it would comprise 15 percent of the estrogens in the world's water supply.

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **American Chemical Society**.

Journal Reference:

1. Amber Wise, Kacie O'Brien, Tracey Woodruff. **Are Oral Contraceptives a Significant Contributor to the Estrogenicity of Drinking Water?†**. *Environmental Science & Technology*, 2010; : 101026133329091 DOI: 10.1021/es1014482

http://www.sciencedaily.com/releases/2010/12/101208125813.htm

How Plants Near Chernobyl Shrug Off Radiation

Chernobyl nuclear station in Ukraine. (Credit: iStockphoto/Iryna Rasko)

ScienceDaily (Feb. 15, 2011) — Scientists are reporting discovery of the biological secrets that enable plants growing near the Chernobyl Nuclear Power Plant to adapt and flourish in highly radioactive soil -- legacy of the 1986 nuclear disaster in the Ukraine. Their study, which helps solve a long-standing mystery, appears in ACS' *Environmental Science & Technology*.

Martin Hajduch and colleagues note that plants have an unexpected ability to adapt to an environment contaminated with radiation following the April 26, 1986 accident at the Chernobyl. Their previous research, for example, showed that soybean plants in the area have adapted to the contaminated soil with certain changes in their proteome. A proteome is the full complement of proteins produced by the genes in a plant or animal. But the broader range of biochemical changes in plants that allow them to thrive in this harsh environment remained unclear.

The scientists grew flax seeds in radiation-contaminated soil in the Chernobyl region and compared their growth to those of seeds grown in non-radioactive soil. Radiation exposure had relatively little effect on the protein levels in the plants, with only about five percent of the proteins altered, they note. Among them were certain proteins involved in cell signaling, or chemical communication, which might help the plants shrug-off radioactivity, the scientists suggest.

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **American Chemical Society**.

Journal Reference:

1. Katarína Klubicová, Maksym Danchenko, Ludovit Skultety, Ján A. Miernyk, Namik M. Rashydov, Valentyna V. Berezhna, Anna Pret'ová, Martin Hajduch. **Proteomics Analysis of Flax Grown in Chernobyl Area Suggests Limited Effect of Contaminated Environment on Seed Proteome**. *Environmental Science & Technology*, 2010; 44 (18): 6940 DOI: 10.1021/es100895s

http://www.sciencedaily.com/releases/2010/12/101208130042.htm

Estrogen Reduces Breast Cancer Stem Cells and Aggression in Breast Cancer, Study Suggests

Ms Vivanco believes that this study presents a new functional aspect of estrogen. (Credit: Image courtesy of Basque Research)

ScienceDaily (Feb. 15, 2011) — A team of researchers at CIC bioGUNE has revealed that estrogen can reduce the risk of breast cancer. Their work shows that estrogen is capable of reducing the number of breast cancer stem cells, which may explain the lower aggression of the tumor and, as a consequence, the possibility of a better prognosis.

The project was published in *Breast Cancer Research and Treatment* and the team will present the results at the International Conference on Breast Cancer to be held in Madrid. The research combined the use of human samples and laboratory cell lines.

The identification of cancer stem cells (or tumor-initiating cells) has opened up a new perspective on breast cancer, with new hopes for treatment in the future. To date treatment against cancer was designed to reduce the mass of the tumour. Nevertheless, what has recently been discovered is that, while traditional treatment is capable of killing most of the cell mass of the tumor, the cancer stem cells are more resistant to common treatment such as chemotherapy and radiation. Thus, in order to cure the cancer with greater efficacy and definitively, it is important to find ways to eliminate cancer stem cells as well.

Estrogen is a hormone which is not without its complexity; on the one hand it is essential for the normal development and functioning of the breast and, on the other, this same hormone induces the proliferation of cancer cells once the breast tumor has appeared, i.e. estrogen is also a risk factor in breast cancer. However, nothing or little has been known until now about the effect of estrogen on the tumor-initiating cells.

Over recent years highly important steps in the fight against breast cancer have been taken, notable enhancing its diagnosis, prognosis and possible treatment, giving rise to a very considerable increase in the survival rates of patients. It had also been proposed that the number of cancerous stem cells is correlated with the aggressiveness of the tumor: The greater the percentage of breast cancer stem cells, the greater the aggressiveness and the worse, thereby, its prognosis.

"To our surprise, what we have seen is that estrogen reduces the proportion of breast stem cells which means a mechanism for explaining this better prognosis observed with tumors that express the estrogen receptor. That is, those tumors expressing the estrogen receptor are less aggressive, better differentiated and thus have a better prognosis," explained María Vivanco, leader of the research team.

Ms Vivanco believes that this study presents a new functional aspect of estrogen, due to its capacity for acting in a different way depending on cellular type.

In the opinion of the CIC bioGUNE researcher, this study "has set out the molecular bases for understanding the direct effect of estrogen on the proportion of stem cells, whether in healthy or cancerous tissue and the fact that the estrogen receptor is an excellent prognostic marker." Moreover, this means there is an explanation for a number of clinical observations, for example: the high levels of estrogen in the blood of postmenopausal patients being associated with less aggressive tumors; the fact that little-differentiated tumors contain more cancerous stem cells, in turn associated with the degree of the tumor, the absence of the estrogen receptor and low survival rate; and the observed benefit of lactation attributed to a greater differentiation in the breast.

The researchers consider that the new study represents a highly important step, opening new doors to developing tools for the prevention of breast cancer.

Story Source:

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

Journal Reference:

1. Bruno M. Simões, Marco Piva, Oihana Iriondo, Valentine Comaills, Jose A. López-Ruiz, Iñaki Zabalza, Jon A. Mieza, Olga Acinas, Maria d.M. Vivanco. **Effects of estrogen on the proportion of stem cells in the breast**. *Breast Cancer Research and Treatment*, 2010; DOI: 10.1007/s10549-010-1169-4

http://www.sciencedaily.com/releases/2011/02/110214083811.htm

Turtle Populations Affected by Climate, Habitat Loss and Overexploitation

Wood turtles occur in the Northeastern United States where conservation concerns include habitat loss, road kill, mortality from farm equipment and over-exploitation (for pets). (Credit: Steven Kirchbaum)

ScienceDaily (Feb. 15, 2011) — The sex of some species of turtles is determined by the temperature of the nest: warm nests produce females, cooler nests, males. And although turtles have been on the planet for about 220 million years, scientists now report that almost half of all turtle species is threatened. Turtle scientists are working to understand how global warming may affect turtle reproduction. To bring attention to this and other issues affecting turtles, researchers and other supporters have designated 2011 as the Year of the Turtle.

Why should we be concerned about the loss of turtles?

"Turtles are centrally nested in the food web and are symbols of our natural heritage. They hold a significant role in many cultures. For example, in many southeast Asian cultures turtles are used for food, pets, and medicine," explains Deanna Olson, a research ecologist and co-chair of the Partners in Amphibian and Reptile Conservation steering committee spearheading the Year of the Turtle campaign.

Turtles (which include tortoises) are central to the food web. Sea turtles graze on the sea grass found on the ocean floor, helping to keep it short and healthy. Healthy sea grass in turn is an important breeding ground for many species of fish, shellfish, and crustaceans. The same processes hold for freshwater and land turtles. For example, turtles contribute to the health of marshes and wetlands, being important prey for a suite of predators. The Year of the Turtle activities, include a monthly newsletter showcasing research and conservation efforts, education and citizen science projects, turtle-themed art, literature, and cultural perspectives, says Olson, a scientist with the Forest Service's Pacific Northwest Research Station.

Olson also co-authored a report, "State of the Turtle," and created a new turtle mapping project for the United States. The report is being translated into other languages for use here and around the world.

"A French translation of the report is already completed, and groups from Bangladesh and Germany signed on recently to help promote turtle conservation, and new partners join us each week," explains Olson.

Here are a few quick facts about turtles:

- About 50 percent of freshwater turtle species are threatened worldwide, more than any other animal group.
- About 20 percent of all turtle species worldwide are found in North America.
- Primary threats to turtles are habitat loss and exploitation.

- Climate change patterns, altered temperatures, affected wetlands and stream flow all are key factors that affect turtle habitats.
- Urban and suburban development causes turtles to be victims to fast-moving cars, farm machinery; turtles can also be unintentionally caught in fishing nets.

What can be done to conserve turtle populations?

- Protect rare turtle species and their habitats.
- Manage common turtle species and their habitats so they may remain common.
- Manage crisis situations such as acute hazards (i.e., oil spills) and rare species in peril.

To read the report and learn more about the Year of the Turtle and how you can participate, please visit http://www.parcplace.org/yearoftheturtle.htm.

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **USDA Forest Service, Pacific Northwest Research Station**.

http://www.sciencedaily.com/releases/2011/02/110202102117.htm

New Research Changes Understanding of C4 Plant Evolution

Dr. David Nelson prepares a sample for stable isotope analysis. (Credit: Image courtesy of University of Maryland Center for Environmental Science)

ScienceDaily (Feb. 15, 2011) — A new analysis of fossilized grass-pollen grains deposited on ancient European lake and sea bottoms 16-35 million years ago reveals that C4 grasses evolved earlier than previously thought. This new evidence casts doubt on the widely-held belief that the rise of this incredibly productive group of plants was driven by a large drop in atmospheric carbon dioxide concentrations during the Oligocene epoch.

The research team, led by University of Maryland Center for Environmental Science Appalachian Laboratory researcher Dr. David Nelson and University of Illinois Professor Feng Sheng Hu, examined the carbon isotope signatures of hundreds of grass-pollen grains and found that C4 grasses were already present on the landscape during the early part of the Oligocene, some 14 million years earlier than previously thought from geological evidence. Their findings are now published online in the journal *Geology* and will shortly appear in the print edition.

"The idea that C4 grasses originated prior to global decreases in carbon dioxide levels requires us to reevaluate the way we think about the evolution of C4 photosynthesis," said Dr. Nelson. "This new information should encourage the examination of alternate evolutionary selection pressures, such as warm temperatures or dry climates."

C4 plants compose only 3 percent of flowering plant species, yet account for about 25 percent global terrestrial productivity. About 60% of C4 species are grasses, and they dominate the world's grassland and savanna biomes, particularly those in warmer, lower latitude areas. Their ecological success results from the way these species concentrate and then fix carbon dioxide in order to power photosynthesis. While the most well known C4 plants are maize and sugar cane, both of which are critical to human consumption, there is a growing interest in their use as biofuels in order to capture carbon from the atmosphere to mitigate increasing global carbon dioxide levels.

The team used an innovative technique pioneered by Dr. Nelson earlier in his career -- the Single Pollen Isotope Ratio Analysis or SPIRAL -- to analyze the samples. The scientists first extracted grains of grass pollen from sedimentary rocks using a micromanipulator; then analyzed the tiny samples using a microcombustion device interfaced with an isotope ratio mass spectrometer in Ann Pearson's laboratory at Harvard University, which houses one of only a handful of these devices in the world. Through this analysis,

they were able to detect the signature of C4 species from their more common C3 counterparts, because C4 and C3 plants take up different ratios of carbon isotopes during photosynthesis.

"SPIRAL enables us to detect C4 grasses at much lower abundances in geological records than previous approaches, which is helping to revolutionize our ability to study their ecology and evolution," said Dr. Hu. University of Illinois graduate student Michael Urban, lead author of the paper, continues to analyze samples from other parts of the world to look at variation in C4-grass abundance in relation to past changes in atmospheric CO_2 and climate.

This research was supported by University of Illinois Research Board, National Science Foundation and the David and Lucille Packard Foundation Fellowships Program.

Story Source:

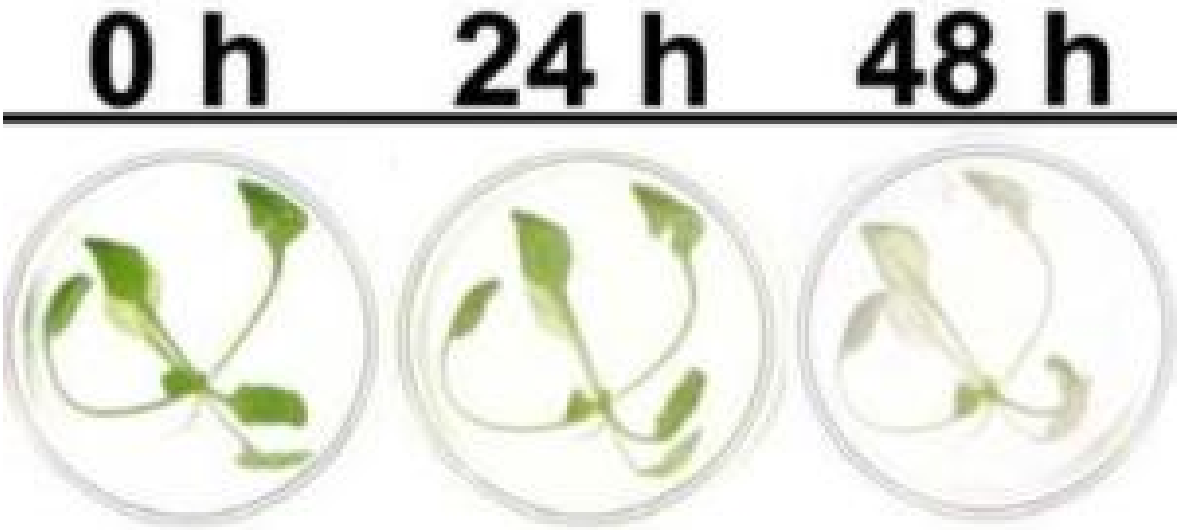
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of Maryland Center for Environmental Science**.

Journal Reference:

1. Michael A. Urban, David M. Nelson, Gonzalo Jiménez-Moreno, Jean-Jaques Châteauneuf, Ann Pearson, and Feng Sheng Hu. **Isotopic evidence of C4 grasses in southwestern Europe during the Early Oligocene-Middle Miocene**. *Geology*, November 12, 2010 DOI: 10.1130/G31117.1

http://www.sciencedaily.com/releases/2010/11/101115142007.htm

Sentries in the Garden Shed: Plants That Can Detect Environmental Contaminants, Explosives



This graphic shows de-greening in plants over a 48-hour period. (Credit: Colorado State)

ScienceDaily (Feb. 15, 2011) — Someday, that potted palm in your living room might go from green to white, alerting you to a variety of nasty contaminants in the air, perhaps even explosives.

The stuff of science fiction you say? Not so, says a Colorado State University biologist whose research is funded in part by Homeland Security's Science and Technology Directorate (DHS S&T), as well as by the Defense Advanced Research Projects Agency (DARPA), the Office of Naval Research (ONR), and others.

Dr. June Medford and her team in the Department of Biology at Colorado State have shown that plants can serve as highly specific sentries for environmental pollutants and explosives. She's enabled a computer-designed detection trait to work in plants. How? By rewiring the plant's natural signaling process so that a detection of the bad stuff results in the loss of green color.

Based on research so far, Medford says the detection abilities of some plants (tobacco is an example) are similar to, or even better, than those of a dog's snout, long the hallmark of a good detector. Best of all, the training time is nothing compared to that of a dog.

"The idea comes directly from nature," Medford said. "Plants can't run or hide from threats, so they've developed sophisticated systems to detect and respond to their environment. We've 'taught' plants how to detect things we're interested in and respond in a way anyone can see, to tell us there is something nasty around, by modifying the way the plant's proteins process chlorophyll. Our system, with improvements, may allow plants to serve as a simple and inexpensive means to monitor human surroundings for substances such as pollutants, explosives, or chemical agents."

The detection traits could be used in any plant and could detect multiple pollutants at once -- changes that can also be detected by satellite. While visible change in the plant is apparent after a day, the reaction can be remotely sensed within a couple of hours. A spectral imaging system designed specifically for the detection of de-greening biosensors would provide the fastest indication of a threat detected by the plants.

Computational design of the detection trait was initially done in collaboration with Professor Homme Hellinga at Duke University, and more recently with Professor David Baker at the University of Washington. The Baker and Hellinga laboratories used a computer program to redesign naturally-occurring proteins called receptors. These redesigned receptors specifically recognize a pollutant or explosive. Medford's lab then modifies these computer redesigned receptors to function in plants, and targets them to the plant cell wall where they can recognize pollutants or explosives in the air or soil near the plant. Once the substance is detected, an internal signal causes the plant to turn white.

Medford and her team want to speed up detection time. The initial or first-generation plants respond to an explosive in hours, but improvements are underway to reduce the response time to just a few minutes. A faster response time increases the likelihood of identifying the threat and preventing an attack.

"At this point in the research, it takes hours to achieve a visible change in the foliage," says Doug Bauer, DHS S&T's program manager on the research. "Ideally, we'd want the reaction to be considerably faster." In addition to faster response times, Bauer says, in the next generation of the research, the indicators may take place in a non-visible spectrum, such as infrared, by using color-changing methods other than the suppression of chlorophyll. That way, law enforcement equipped with the appropriate sensors would be alerted, but a terrorist would not be tipped off.

A decentralized, ubiquitous detection capability could allow the early detection of bomb-manufacturing sites, instead of waiting for a potential bomber to show up at a transportation hub or other target zone.

There are still many, many years of research to go before any possible deployment of plant sentinels. Once the research achieves a point where it may be possible to deploy, there are other considerations that will have to be taken into account and additional studies to be conducted. For example, USDA regulations stipulate that genetically-altered plants must go through a rigorous study on their impact to and interaction with the environment before they can be cultivated or planted in the United States.

This work could eventually be used for a wide range of applications such as security in airports or monitoring for pollutants such as radon, a carcinogenic gas that can be found in basements. Harnessing plants as bio-sensors allows for distributed sensing without the need for a power supply. "One day, plants may assist law enforcement officers in detecting meth labs or help emergency responders determine where hazardous chemicals are leaking," Bauer says. "The fact that DoD, DHS and a variety of other agencies contributed to funding this research is an indicator of the breadth of possibilities."

Financial support for this research was provided by the Defense Advanced Research Projects Agency (DARPA), the Office of Naval Research (ONR), the Bioscience Discovery Evaluation Grant Program through the Colorado Office of Economic Development and International Trade, the National Science Foundation (NSF), Department of Homeland Security Science and Technology Directorate (DHS S&T), and Gitam Technologies. Most recently, Medford and her team received a three-year, $7.9 million grant from the DoD's Defense Threat Reduction Agency.

The research from Medford's team appeared in the peer-reviewed journal *PLoS ONE*.

Story Source:

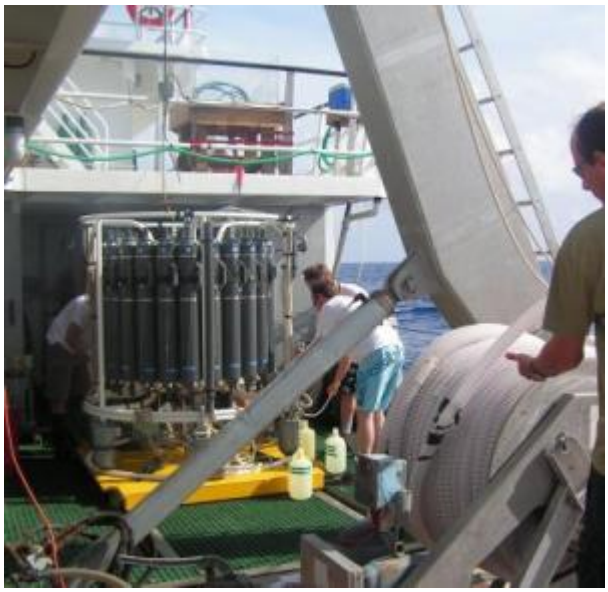
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **US Department of Homeland Security - Science and Technology**, via EurekAlert!, a service of AAAS.

Journal Reference:

1. Mauricio S. Antunes, Kevin J. Morey, J. Jeff Smith, Kirk D. Albrecht, Tessa A. Bowen, Jeffrey K. Zdunek, Jared F. Troupe, Matthew J. Cuneo, Colleen T. Webb, Homme W. Hellinga, June I. Medford. **Programmable Ligand Detection System in Plants through a Synthetic Signal Transduction Pathway**. *PLoS ONE*, 2011; 6 (1): e16292 DOI: 10.1371/journal.pone.0016292

http://www.sciencedaily.com/releases/2011/02/110215123541.htm

New Way to Estimate Global Rainfall and Track Ocean Pollution



University of Miami (UM) scientists have found a new way to estimate global rainfall and track ocean pollution. A portion of the precipitation sampling for the study was carried out at this site, located on the extreme west end of Bermuda, and at the Bermuda Institute of Ocean Sciences (BIOS). The site was erected in the late 1980s by UM Professor Joe Prospero's aerosol research group as part of the Atmosphere-Ocean Research Program. The station is now operated by BIOS. (Credit: UM/RSMAS)

ScienceDaily (Feb. 15, 2011) — A study by scientists at the University of Miami (UM) Rosenstiel School of Marine & Atmospheric Science suggests a new way to estimate how much of the ocean's pollution is falling from the sky. The new findings can help improve scientific understanding of how toxic airborne chemicals, from the burning of fossil fuels and industrial power plants emissions, are impacting the oceans globally.

By measuring Beryllium-7 (^{7}Be) isotope concentrations in the ocean, which is found naturally throughout Earth's atmosphere, Rosenstiel School scientists David Kadko and Joseph Prospero were able to provide a method to accurately estimate rainfall in remote regions of the ocean. The two-year study measured ^{7}Be deposited in rain collectors at two sites in Bermuda and compared these estimates to those observed in the nearby Sargasso Sea.

"Over vast areas of the oceans the only rainfall data available are those made by using conventional rain collectors placed on islands," said Prospero, professor of marine and atmospheric chemistry at the UM Rosenstiel School. "However, rainfall on the island is not necessarily representative of that which falls in the surrounding ocean. Our paper shows that properly placed rain collectors on Bermuda do yield rainfall rates that agree with those determined through the ^{7}Be measurements."

Rainfall is a major pathway by which man-made airborne pollutants and other naturally occurring chemicals enter the oceans. Berrylium-7, like man-made pollutants and other naturally occurring chemicals, attaches itself to atmospheric dust particles and enters the ocean during rain events. By understanding this process, scientists can establish new ways to quantify airborne pollutants deposited to the ocean.

"The accumulation of ^{7}Be in the upper ocean provides a means of assessing ^{7}Be deposition to the ocean on regional and global scales," said Kadko, professor marine and atmospheric chemistry of at the Rosenstiel and lead author of the study. "This then can be used to assess the deposition of other chemical species."

Story Source:

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

Journal Reference:

1. David Kadko, Joseph Prospero. **Deposition of ^{7}Be to Bermuda and the regional ocean: Environmental factors affecting estimates of atmospheric flux to the ocean**. *Journal of Geophysical Research*, 2011; 116 (C2) DOI: 10.1029/2010JC006629

http://www.sciencedaily.com/releases/2011/02/110215111849.htm

Reconfigurable Supercomputing Outperforms Rivals in Important Science Applications

University of Florida computer researcher Herman Lam (left) and Alan George, founder and director of the NSF CHREC Center, display UF's supercomputer, the Novo-G, on Feb. 8, 2011. The Novo-G, built and developed at UF, is believed to be the world's most powerful reconfigurable computer. (Credit: Photo by Eric Zamora/UF News Bureau)

ScienceDaily (Feb. 15, 2011) — University of Florida researchers say their supercomputer, named Novo-G, is the world's fastest reconfigurable supercomputer and is able to perform some important science applications faster than the Chinese supercomputer touted as the world's most powerful.

In November, the TOP500 list of the world's most powerful supercomputers, for the first time ever, named the Chinese Tianhe-1A system at the National Computer Center in Tainjin, China as No. 1.

In his state of the union speech, President Barack Obama noted, "Just recently, China became home of the world's largest solar research facility, and the world's fastest computer."

But that list does not include reconfigurable supercomputers such as Novo-G, built and developed at the University of Florida, said Alan George, professor of electrical and computer engineering, and director of the National Science Foundation's Center for High-Performance Reconfigurable Computing, known as CHREC.

"Novo-G is believed to be the most powerful reconfigurable machine on the planet and, for some applications, it is the most powerful computer of any kind on the planet," George said.

"It is very difficult to accurately rank supercomputers because it depends upon what you want them to do," George said, adding that the TOP500 list ranks supercomputers by their performance on a few basic routines in linear algebra using 64-bit, floating-point arithmetic.

However, a significant number of the most important applications in the world do not adhere to that standard, including a growing list of vital applications in health and life sciences, signal and image processing, financial science, and more under study with Novo-G at Florida.

Most of the world's computers, from smart-phones to laptops to Tianhe-1A, feature microprocessors with fixed-logic hardware structures. All software applications for these systems must conform to these fixed structures, which can lead to a significant loss in speed and increase in energy consumption.

By contrast, with reconfigurable machines, a relatively new and highly innovative form of computing, the architecture can adapt to match the unique needs of each application, which can lead to much faster speed and less wasted energy due to adaptive hardware customization.

Novo-G uses 192 reconfigurable processors and "can rival the speed of the world's largest supercomputers at a tiny fraction of their cost, size, power, and cooling," the researchers noted in a new article on Novo-G published in the January-February edition of *IEEE Computing in Science and Engineering* magazine.

Conventional supercomputers, some the size of a large building, can consume up to millions of watts of electrical power, generating massive amounts of heat, whereas Novo-G is about the size of two home refrigerators and consumes less than 8,000 watts.

Later this year, researchers will double the reconfigurable capacity of Novo-G, an upgrade only requiring a modest increase in size, power, and cooling, unlike upgrades with conventional supercomputers.

In their article, the researchers discuss Novo-G and its obvious advantages for use in certain applications such as genome research, cancer diagnosis, plant science, and the ability to analyze large data sets.

Herman Lam, an electrical and computer engineering professor and co-investigator on Novo-G, said some vital science applications that can take months or years to run on a personal computer can run in minutes or hours on the Novo-G, such as applications for DNA sequence alignment at UF's Interdisciplinary Center for Biotechnology Research.

CHREC includes research sites at four universities including Florida, Brigham Young, George Washington and Virginia Tech. In addition, there are more than 30 partners in CHREC, such as the U.S. Air Force, Army, and Navy, NASA, National Security Agency, Boeing, Honeywell, Lockheed Martin, Monsanto, Northrop Grumman, and the Los Alamos, Oak Ridge and Sandia National Labs.

Story Source:

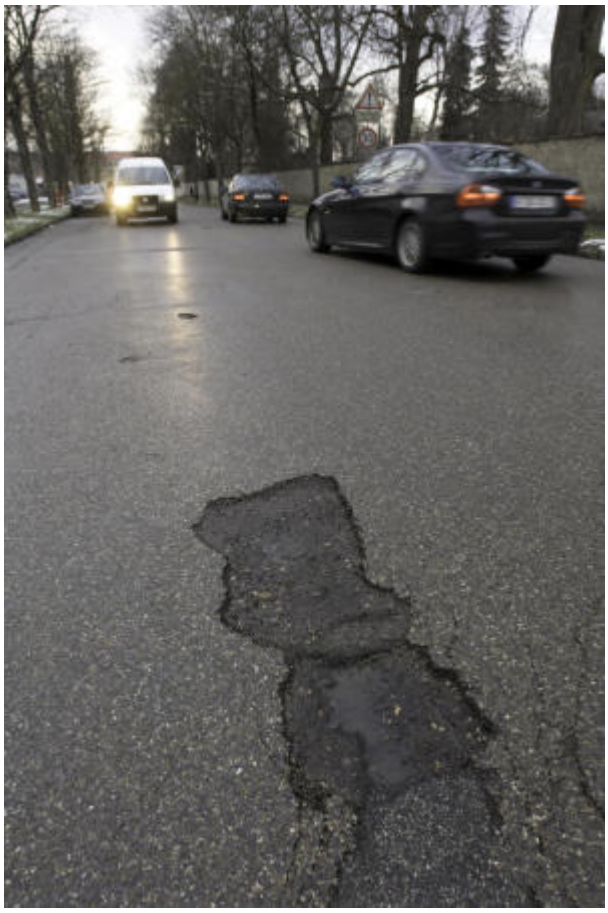
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of Florida**.

Journal Reference:

1. Alan George, Herman Lam, Greg Stitt. **Novo-G: At the Forefront of Scalable Reconfigurable Supercomputing**. *Computing in Science & Engineering*, 2011; 13 (1): 82 DOI: 10.1109/MCSE.2011.11

http://www.sciencedaily.com/releases/2011/02/110215111813.htm

'Mashup' Technologies: Better Contact With Public Authorities



Mashups will enable people to inform public authorities about potholes and cracks in the road quickly and without bureaucracy. (Credit: © Fraunhofer)

ScienceDaily (Feb. 15, 2011) — Mashup technologies and mobile applications will help to close the communication gap between government bodies and the general public. They can be used, for example, to send messages to local authorities. Fraunhofer research scientists have developed individual solutions to facilitate rapid contact with government institutions.

Potholes in the road or a park bench in need of repair -- we all come across these or similar problems every now and then. If only there were a simple way of reporting them to the right department of the public administration! The latest mashup technology and mobile applications make it possible to come up with solutions.

Inspired by the UK website www.fixmystreet.com, the Fraunhofer Institute for Open Communication Systems FOKUS in Berlin is taking this approach further. Damage reports can be assigned GPS coordinates by cell phone and entered. The system then provides an overview of communications received and indicates whether the same matter has been reported by someone else.

As used in information and communication technologies, the term 'mashup' refers to the mixing or combination of data, types of presentation and functionalities from various sources in order to create new services. One example is the placing of restaurant reviews in online maps such as Google Maps. Fraunhofer

FOKUS's Government Mashups research project is putting the technology at the public sector's disposal. Solutions that already exist are being developed further to meet the requirements of government administration and the relevant public sector staff are being assisted in the technical implementation of these new services. "Mashups hold enormous potential for public authorities because they link up internal and external data quickly and cheaply," says project manager Dipl.-Ing. Jens Klessmann. "Without any knowledge of computer programming and at little cost administrative staff can create new mashups which can be adapted effortlessly to changing requirements."

Numerous possible applications exist: In addition to complaints management, the use of public funding can for instance be graphically represented, restaurant reviews can be linked to the results of food hygiene inspections, statistics and other official data can be made more easily accessible, and capacity utilization at different airports can be illustrated in order to coordinate rescue services in the event of a disaster.

Such projects are underpinned by statutory regulations and political requirements. For example, laws on the freedom and re-use of government information already require public bodies to provide official data. In its current program to promote networked and transparent administration the German government has announced that it intends to develop a common strategy for open government. This will include the provision of open data, which are the raw material for government mashups. In addition, governments and public bodies find themselves under growing pressure to justify and explain the increasingly complex procedures underlying their actions. Mashups can be used to explain and visualize these matters.

At CeBit 2011 Fraunhofer FOKUS will present two advanced demonstrators for mashups. Visitors will be invited to take a photo of a pothole on a smart phone and send it to a fictitious city authority as a complaint. And the research scientists will use statistical data from the World Bank to demonstrate how such information can be translated, processed and visualized so that anyone interested can download it.

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/2011/02/110215111154.htm

New Probe of Proton Spin Structure: How Quarks of Different Flavors Contribute to Spin

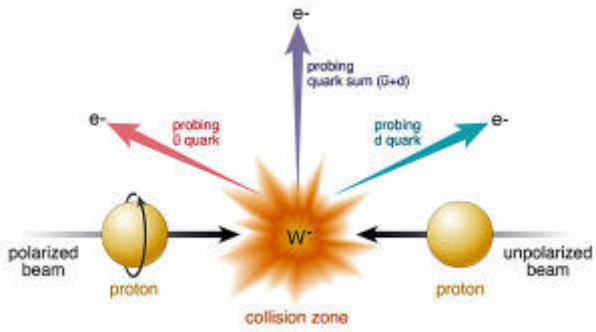


Illustration of a new measurement using W boson production in polarized proton collisions at RHIC. Collisions of polarized protons (beam entering from left) and unpolarized protons (right) result in the production of W bosons (in this case, W-). RHIC's detectors identify the particles emitted as the W bosons decay (in this case, electrons, e-) and the angles at which they emerge. The colored arrows represent different possible directions, which probe how different quark flavors (e.g., "anti-up," k; and "down," d) contribute to the proton spin. (Credit: Image courtesy of DOE/Brookhaven National Laboratory)

ScienceDaily (Feb. 15, 2011) — Scientists hoping to unravel the mystery of proton spin at the Relativistic Heavy Ion Collider (RHIC), a 2.4-mile-circumference particle accelerator at the U.S. Department of Energy's (DOE) Brookhaven National Laboratory, have a new tool at their disposal -- the first to *directly* explore how quarks of different types, or "flavors," contribute to the overall spin of the proton.

The technique, described in papers just published by RHIC's STAR and PHENIX collaborations in *Physical Review Letters*, relies on the measurement of particles called W bosons, the mediators of the weak force responsible for the decay of radioactive nuclei.

"Exploring the mystery of proton spin has been one of the key scientific research goals at RHIC," said Steven Vigdor, Brookhaven's Associate Laboratory Director for Nuclear and Particle Physics. "Like many scientific mysteries, this one turns out to be more complex the more we learn about it. The W boson measurements were enabled by new detection techniques at RHIC's STAR and PHENIX experiments and by extending RHIC's world-record energies for the acceleration of proton beams with a distinct spin orientation preference. The results will allow us to tease apart subtle details that were previously inaccessible, and should move the field closer to a quantitative understanding of proton spin structure and dynamics."

Spin is a quantum property that describes a particle's intrinsic angular momentum. Like charge and mass, it's part of a particle's identity, whose magnitude is the same for all particles of a given type. But unlike charge and mass, spin has a direction that can be oriented differently for individual particles of a given species. The interactions among particles inside atoms, nuclei, and protons depend critically on their relative spin orientations, with influence on a wide range of electrical, magnetic, optical, and other properties of matter. Yet despite the fact that proton spin is used in everyday applications like magnetic resonance imaging (MRI), exactly how -- and how much -- the individual particles that make up protons contribute to spin remains a mystery.

Scientists know that the quarks inside a proton each have their own intrinsic spin. But numerous experiments have confirmed that a directional preference among all these quark spins can account for only about 25 percent of the proton's total spin. RHIC was built with the ability to collide polarized protons -- protons whose spins could be aligned in a controlled way -- so scientists could probe other factors that might account for the "missing" spin. Much of the equipment needed to realize this unique capability was provided by the RIKEN

Institute of Physical and Chemical Research of Japan, whose researchers form a critical part of the international collaborations carrying out this work.

After beginning polarized proton collisions at RHIC late in 2001, the first place the scientists looked for the missing spin was the gluons, the particles that hold a proton's quarks together via the strong force.

"The shock so far has been that we haven't found gluons carrying much of the spin," said PHENIX spokesperson Barbara Jacak, a physicist at Stony Brook University. Measurements from the STAR detector agree. After several polarized proton runs at various energies, RHIC data suggest with more and more certainty that gluons contribute much less than originally speculated to proton spin, so the source of the spin still remains a mystery.

The scientists acknowledge that they haven't been able to look at *all* the gluons, particularly those that carry tiny fractions of the proton's overall momentum. "It's like we're looking for missing keys under a narrow-focus street lamp, and we'd like a lamp with broader illumination," Jacak said.

But as they continue to work on that part of the puzzle, they also have a new way to look at spin.

Thanks to new detection techniques and the ability to run polarized proton collisions at very high energies -- 500 GeV, or 500 billion electron volts -- RHIC scientists at both PHENIX and STAR are able to directly probe the polarization contributions from different flavored quarks (known by the names "up" and "down") inside protons for the first time.

"All of the earlier measurements that attempted to separate quark spin contributions according to flavor were done indirectly, and they looked primarily at the contribution of the three leading, or valence, quarks in the proton," said Bernd Surrow, a Massachusetts Institute of Technology physicist and deputy spokesperson of the STAR collaboration. "This new method of measuring W bosons gives us direct access to quarks known as 'sea quarks,' which wink in and out of existence as gluons split and reform within the protons."

Sea quarks are always produced in quark/antiquark pairs and have exceedingly short lifetimes. But at the very high energies achieved in RHIC's colliding proton beams, these fleeting quarks and antiquarks can collide, or interact, to produce relatively heavy W bosons. So far, RHIC's experiments have detected Ws by looking for electrons and positrons (positively charged electrons) that form as the Ws decay. The charge of the decay products -- whether electrons or positrons -- directly reflects the charge of the Ws, which in turn tells what flavor of antiquarks were involved in the collision -- whether anti-up or anti-down.

By comparing the number of Ws produced when bunches of RHIC's colliding protons are polarized in the direction of the beam's motion with the number produced when the protons are polarized in the opposite direction, the scientists can directly measure the degree to which the antiquark spins point in a preferred direction with respect to the overall proton spin. This robust measurement technique relies on a fundamental, and very well understood, property of the weak interaction by which the Ws are produced, namely, its extreme violation of mirror symmetry.

"Observation of this extreme effect in weak interactions for the first time in polarized proton-proton collisions at RHIC is itself a major milestone," said Hideto En'yo, director of the RIKEN Nishina Center for Accelerator-Based Science, which established the RIKEN-BNL Research Center (RBRC) to nurture a new generation of physicists interested in studying the strong force and spin physics at RHIC. "It is gratifying to see our large investments in polarization equipment pay off with such large and cleanly interpretable spin effects."

"You would think you would get equal numbers of anti-up and anti-down quarks inside a proton. But previous experiments have shown that they are very different," Surrow said. "That means there is a lot of uncertainty about the underlying mechanism of how these sea quarks pop in and out of existence. It also indicates that the different flavors may behave differently in terms of how they contribute to spin."

Added Jacak, "Understanding these differences won't by itself solve the spin mystery, but it will give us a clearer picture of one piece of the puzzle, the sea quark contribution."

Research at RHIC is funded primarily by the U.S. Department of Energy's Office of Science, and by various national and international collaborating institutions.

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **DOE/Brookhaven National Laboratory**.

Journal References:

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http://www.sciencedaily.com/releases/2011/02/110215102846.htm

US Secret Service Moves Tiny Town to Virtual Tiny Town: Teaching Secret Service Agents and Officers How to Prepare a Site Security Plan

An instructor uses a prototype touch kiosk to move and align 3-D modeled assets with the Site Security Planning Tool. (Credit: United States Secret Service)

ScienceDaily (Feb. 15, 2011) — Chemical releases, suicide bombers, air and subsurface threats: the U.S. Secret Service needs to be prepared to handle these real-life incidents. Training to respond to such incidents, however, has been more theoretical than practical.

Now, with help from the Department of Homeland Security (DHS) Science & Technology Directorate (S&T), the Secret Service is giving training scenarios a high-tech edge: moving from static tabletop models to virtual kiosks with gaming technology and 3D modeling.

For the past 40 years, a miniature model environment called "Tiny Town" has been one of the methods used to teach Secret Service agents and officers how to prepare a site security plan. The model includes different sites -- an airport, outdoor stadium, urban rally site and a hotel interior -- and uses scaled models of buildings, cars and security assets. The scenario-based training allows students to illustrate a dignitary's entire itinerary and accommodate unrelated, concurrent activities in a public venue. Various elements of a visit are covered, such as an arrival, rope line or public remarks. The class works as a whole and in small groups to develop and present their security plan.

Enter videogame technology. The Secret Service's James J. Rowley Training Center near Washington, D.C., sought to take these scenarios beyond a static environment to encompass the dynamic threat spectrum that exists today, while taking full advantage of the latest computer software technology.

The agency's Security and Incident Modeling Lab wanted to update Tiny Town and create a more relevant and flexible training tool. With funding from DHS S&T, the Secret Service developed the Site Security Planning Tool (SSPT), a new training system dubbed "Virtual Tiny Town" by instructors, with high-tech features:

- 3D models and game-based virtual environments
- Simulated chemical plume dispersion for making and assessing decisions
- A touch interface to foster collaborative, interactive involvement by student teams
- A means to devise, configure, and test a security plan that is simple, engaging, and flexible
- Both third- and first-person viewing perspectives for overhead site evaluation and for a virtual "walk-through" of the site, reflecting how it would be performed in the field.

The new technology consists of three kiosks, each composed of a 55" Perceptive Pixel touch screen with an attached projector and camera, and a computer running Virtual Battle Space (VBS2) as the base simulation game. The kiosks can accommodate a team of up to four students, and each kiosk's synthetic environment, along with the team's crafted site security plan, can be displayed on a large wall-mounted LED 3D TV monitor for conducting class briefings and demonstrating simulated security challenges.

In addition to training new recruits, SSPT can also provide in-service protective details with advanced training on a range of scenarios, including preparation against chemical, biological or radiological attacks, armed assaults, suicide bombers and other threats.

Future enhancements to SSPT will include modeling the resulting health effects and crowd behaviors of a chemical, radiological or biological attack, to better prepare personnel for a more comprehensive array of scenarios and the necessary life-saving actions required to protect dignitaries and the public alike.

The Site Security Planning Tool development is expected to be completed and activated by spring 2011.

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **US Department of Homeland Security - Science and Technology**, via EurekAlert!, a service of AAAS.

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Getting Cars Onto the Road Faster

The fender with integrated LED tail light developed in the Pegasus project has been produced for demonstration purposes. (Credit: © Fraunhofer ICT)

ScienceDaily (Feb. 15, 2011) — Auto manufacturers are looking for shorter production times, faster logistics processes, new materials and technologies. A novel software platform will help companies to achieve these goals by reducing not only the development times but also the development costs.

The auto industry faces major challenges. New models are entering the market at ever shorter intervals, products are becoming more complex, and the trend towards electric cars requires modified vehicle structures. European production sites are coming under increasing cost pressure from low-wage countries. Cost reductions, shorter production times, new materials and innovative assembly techniques are needed if companies are to remain competitive. To achieve these goals, 23 business and research organizations are participating in the EU's Pegasus project (www.pegasus-eu.net). One of the research partners is the Fraunhofer Institute for Chemical Technology ICT in Pfinztal, which is contributing its expertise in the polymer engineering sector. The project partners have jointly developed a software platform to reduce development times and costs.

The Integrated Design and Engineering Environment (IDEE) is a CAD/CAE/CAM software system which is connected to an intelligent database. It analyzes the functional requirements of a product and identifies appropriate materials at an early stage of the development process. If, for example, a car roof is to be made in a different material than before, it is not necessary to conduct a new development process. Instead, the design engineers enter the component data into the software system, which assesses the information and then selects suitable materials and manufacturing processes. The platform also provides engineering guidelines for designing the tools that will be used to produce the component. The project partners have demonstrated how this platform could work on the example of a fender with integrated LED tail light. "We used the original fender from a Smart. Our project demonstrates how this complex component can be produced more quickly and cheaply with new processing techniques, materials, bonding agents and tools," says Timo Huber, a scientist at Fraunhofer ICT. Instead of conventional lamps, the project partners fitted LED tail lights to the fender. This reduced the number of separate parts from eight to five, and the number of processing steps from twelve to five. Material and cost savings were also achieved by using conductor paths made of electrically conductive polymer. The conductive carbon nanotubes conduct the electricity from the connector to the LEDs and render metallic conductor structures superfluous.

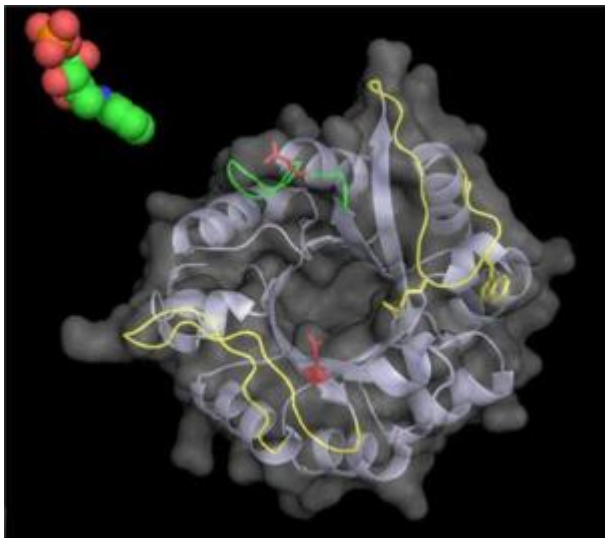
A further example application: So that components such as the LED tail lights can be dismantled more quickly, they are bonded using a special adhesive. For this the research scientists at Fraunhofer ICT and their project partners developed a new microwave-active adhesive bonding system. When irradiated with microwaves the individual components lose their adhesion and can be easily taken apart. This means that parts can be efficiently recycled into different categories. "In addition, we dyed the fender using newly developed pigments based on special nanoparticles," states Huber. These nanostructures can be worked in particularly evenly, to dye plastics such as polypropylene. This means fewer pigments are needed than usual. "We have also taken the importance of protecting the climate into account. Further developments in local fiber reinforcement of structural vehicle components will reduce weight and therefore emissions of CO2," the scientist adds, and sums up: "All in all the IDEE system will shorten development times, cut the number of assembly steps and reduce the amount of material consumed." IDEE is still under development, but it can already be used to produce simple components. The software should be ready and available to the auto industry in about a year's time.

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/2011/02/110215102645.htm

Two in One: Multi-Tasking Protein Provides New Approaches for Anti-Tuberculosis Drugs



Mycobacterium tuberculosis' enzyme PriA has the unique ability to alter its active site depending on which of two molecules it is interacting with. (Credit: EMBL/Felix List)

ScienceDaily (Feb. 15, 2011) — Scientists from the European Molecular Biology Laboratory (EMBL) in Hamburg, Germany, have revealed new insights into the workings of enzymes from a group of bacteria including *Mycobacterium tuberculosi*s, the bacterium that causes tuberculosis. The findings present possible new opportunities for developing organism-specific drugs, which target the pathogen but leave other microorganisms, which are beneficial to us, untouched.

The research was published in the *Proceedings of the National Academy of Sciences*.

Tuberculosis remains one of the largest threats to human health worldwide, and one of the most frequent causes of death in HIV patients. With the increasing emergence of strains of *Mycobacterium tuberculosis* that are hyper-resistant to drugs, it becomes ever more urgent that novel treatments be developed, and the search for novel strategies for drug development is an important step in this process.

In the current study, Matthias Wilmanns and his group at EMBL identified a multi-tasking enzyme from *Mycobacterium tuberculosis* that catalyses reactions on two different molecules, or substrates. In most organisms, cells need two specific enzymes, known as HisA and TrpF, in order to produce two essential amino acids -- histidine and tryptophan. However, in *Mycobacterium tuberculosis*, the encoding gene for TrpF is missing, and the two reactions are instead catalysed by a single enzyme, which is able to recognize and bind to two different substrates. This enzyme is known as PriA.

Using the *Mycobacterium tuberculosis* version of the PriA enzyme as a model, the researchers were able to unravel the hitherto unknown mechanism of bi-substrate specific binding observed in this group of bacteria.

"When we solved the three-dimensional structure of PriA, we found that it has the unique ability to form two different substrate-specific active sites," Wilmanns says: "it can form a reaction-specific active site, or undergo what we call 'substrate-induced metamorphosis' to form a different active site."

To further verify these observations, Wilmanns and colleagues screened 20,000 small molecule compounds, and identified a handful which inhibited both PriA-catalysed reactions but had no effect on TrpF activity.

"We believe that this ability for bi-substrate catalysis in *Mycobacterium tuberculosis* could be a new opportunity for future drug development," Wilmanns concludes: "This organism-specific reaction process could be exploited, since only the pathogen but none of the other bacteria living in or on humans, many of which are important for our well being, would be targeted."

Story Source:

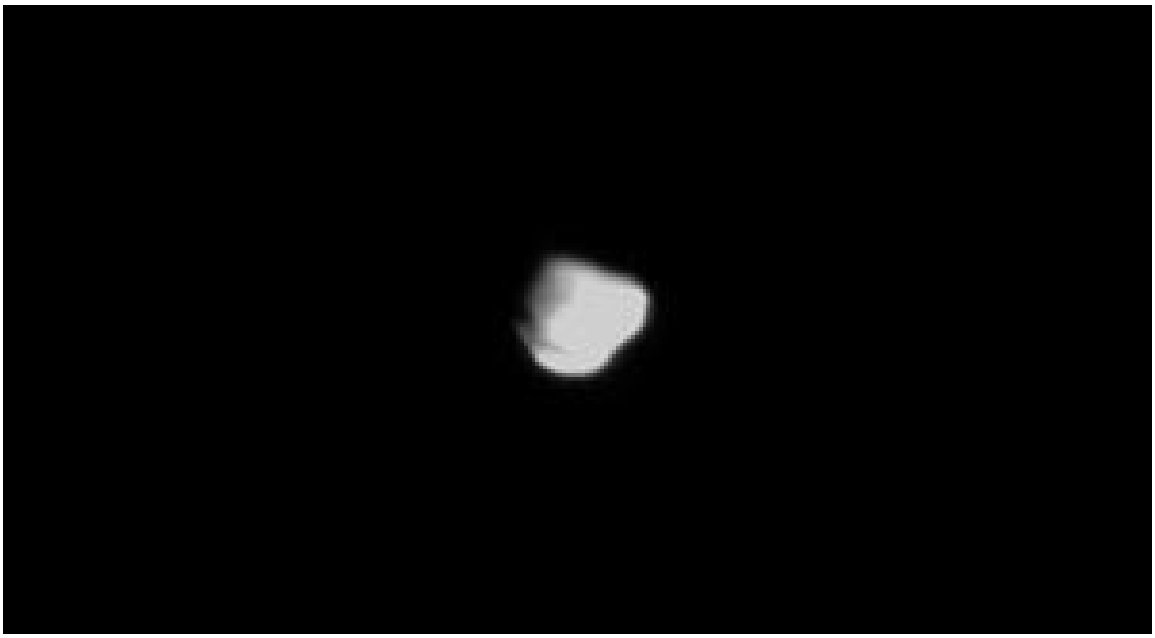
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **European Molecular Biology Laboratory (EMBL)**.

Journal Reference:

1. A. V. Due, J. Kuper, A. Geerlof, J. P. v. Kries, M. Wilmanns. **Bisubstrate specificity in histidine/tryptophan biosynthesis isomerase from Mycobacterium tuberculosis by active site metamorphosis**. *Proceedings of the National Academy of Sciences*, 2011; DOI: 10.1073/pnas.1015996108

http://www.sciencedaily.com/releases/2011/02/110215081926.htm

Comet Hunter's First Images of Tempel 1



NASA's Stardust-NExT mission transmitted the first image it took during its approach to comet Tempel 1 at 8:35 p.m. PST (11:35 p.m. EST) on Feb. 14, 2011, from a distance of approximately 2,462 kilometers (1,530 miles). The comet was first visited by NASA's Deep Impact mission in 2005. (Credit: NASA/JPL-Caltech/Cornell)

ScienceDaily (Feb. 15, 2011) — Mission controllers at NASA's Jet Propulsion Laboratory, Pasadena, Calif., have begun receiving the first of 72 anticipated images of comet Tempel 1 taken by NASA's Stardust spacecraft.The first six, most distant approach images are available at http://www.nasa.gov/stardust and http://www.jpl.nasa.gov. Additional images, including those from closest approach, are being downlinked in chronological order and will be available later in the day.

A news conference previously planned for 10 a.m. PST (1 p.m. EST) will be held later in the day, to allow scientists more time to analyze the data and images. A new time will be announced later this morning.Stardust-NExT is a low-cost mission that expands on the investigation of comet Tempel 1 initiated by NASA's Deep Impact spacecraft. JPL, a division of the California Institute of Technology in Pasadena, manages Stardust-NExT for NASA's Science Mission Directorate, Washington, D.C. Joe Veverka of Cornell University, Ithaca, N.Y., is the mission's principal investigator. Lockheed Martin Space Systems, Denver, built the spacecraft and manages day-to-day mission operations.

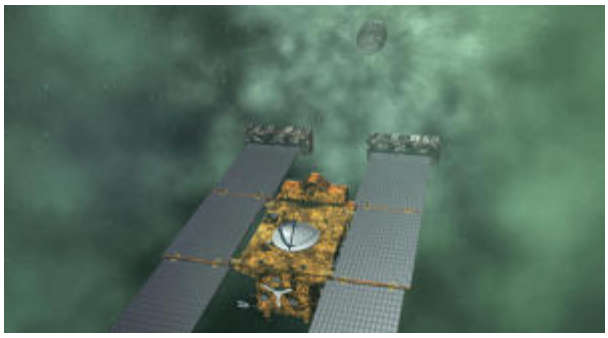
More information about Stardust-NExT is available at http://stardustnext.jpl.nasa.gov .

Story Source:

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

http://www.sciencedaily.com/releases/2011/02/110215075759.htm

NASA's Stardust Spacecraft Completes Comet Flyby



Artist's concept of NASA's Stardust-NExT mission, which will fly by comet Tempel 1 on Feb. 14, 2011. (Credit: NASA/JPL-Caltech/LMSS)

ScienceDaily (Feb. 15, 2011) — Mission controllers at NASA's Jet Propulsion Laboratory, Pasadena, Calif., watched as data downlinked from the Stardust spacecraft indicated it completed its closest approach with comet Tempel 1. An hour after closest approach, the spacecraft turned to point its large, high-gain antenna at Earth. It is expected that images of the comet's nucleus collected during the flyby will be received on Earth starting at about midnight California time (3 a.m. EST on Tuesday, Feb. 15).

Preliminary data already transmitted from the spacecraft indicate the time of closest approach was about 8:39 p.m. PST (11:39 p.m. EST), at a distance of 181 kilometers (112 miles) from Tempel 1.

This is a bonus mission for the comet chaser, which previously flew past comet Wild 2 and returned samples from its coma to Earth. During this bonus encounter, the plan called for the spacecraft to take images of the comet's surface to observe what changes occurred since a NASA spacecraft last visited. (NASA's Deep Impact spacecraft executed an encounter with Tempel 1 in July 2005).

Stardust-NExT is a low-cost mission that will expand the investigation of comet Tempel 1 initiated by NASA's Deep Impact spacecraft. JPL, a division of the California Institute of Technology in Pasadena, manages Stardust-NExT for NASA's Science Mission Directorate, Washington, D.C. Lockheed Martin Space Systems, Denver, built the spacecraft and manages day-to-day mission operations.

For more information about Stardust-NExT, visit: http://stardustnext.jpl.nasa.gov .

Story Source:

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

http://www.sciencedaily.com/releases/2011/02/110215075654.htm

Satisfied in Submerged Cages: Salmon Happy in Deeper Water

Conventional sea cages. (Credit: Image courtesy of The Research Council of Norway)

ScienceDaily (Feb. 14, 2011) — The salmon swim bladder requires an air supply in order to regulate the fish's buoyancy. Until now, however, no one realised just how seldom salmon need to surface for air. This need is being quantified by researchers at CREATE, one of 14 Norwegian Centres for Research-based Innovation established four years ago with funding from the Research Council of Norway.

"We kept salmon in completely submerged cages for 17 days," reports Arne Fredheim, Research Manager at CREATE. "The individuals swam somewhat faster than usual but they did not exhibit stress. We also tested the pain threshold for how long salmon can continuously stay below the surface. It took four months for them to become excessively stressed."

The centre's researchers believe that submerged cages can be used for extended periods -- as long as the cages are lifted to the surface at regular intervals to give the fish access to air.

"But more research is needed to adequately determine their threshold limits," asserts Dr Fredheim.

Using submerged cages is advantageous for avoiding storm damage and resisting invasion by algae and sea lice. There is also growing evidence that submersion may increase the effectiveness of sea lice medicines.

CREATE carries out research and develops technology for the sea-cage phase of "fattening up" production fish for the market.

"Our research is part technology and part biology, and interactions are crucial. For instance, we are examining the effects of aquatic temperature, salinity and oxygen content on fish behaviour and welfare. This is fundamental knowledge on which we will base our technology development," explains Dr Fredheim.

In the project "Cage Environment," researchers at CREATE studied hypoxia (oxygen depletion in the aquatic environment) to ascertain critical threshold limits for fish welfare. At the same time, they gained a better understanding of how seawater flows through cage netting. Even though aquaculture sites are placed in sea

areas with strong natural currents, there can be too little oxygen in the water at times -- which impedes fish digestion.

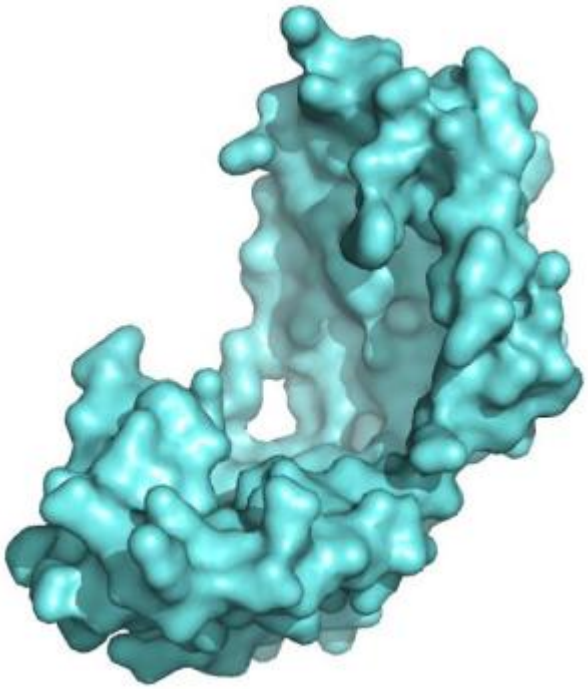
"We have developed models for calculating how strong the current must be in relation to cage size and fish density," says Senior Scientist Pål Lader, who works at CREATE. "We have also studied how fish group behaviour affects the current. They often swim in circles en masse, creating a rising spiral current."

Story Source:

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

http://www.sciencedaily.com/releases/2011/02/110211074743.htm

Quest for Designer Bacteria Uncovers a 'Spy'



A cradle-shaped molecular assistant called Spy aids in protein refolding and protects unstable proteins from being cut up or sticking to other proteins. (Credit: Shu Quan)

ScienceDaily (Feb. 14, 2011) — Scientists have discovered a molecular assistant called Spy that helps bacteria excel at producing proteins for medical and industrial purposes.

Bacteria are widely used to manufacture proteins used in medicine and industry, but the bugs often bungle the job. Many proteins fall apart and get cut up inside the bacteria before they can be harvested. Others collapse into useless tangles instead of folding properly, as they must in order to function normally.

A research team led by James Bardwell, who is a professor of molecular, cellular and developmental biology and of biological chemistry, as well as a Howard Hughes Medical Institute investigator, at the University of Michigan, developed a way to coerce bacteria into making large quantities of stable, functional proteins. Then, in exploring why these designer bacteria were so successful, the scientists discovered the molecular helper, Spy.

The research is scheduled for online publication Feb.13 in the journal *Nature Structural & Molecular Biology.*

In the first phase of the research, the team designed biosensors that directly link protein stability to the antibiotic resistance of bacteria. When a poorly folded, unstable protein is inserted into the middle of the biosensor in a bacterium, it disrupts the bug's resistance to antibiotics. When the protein is stabilized, resistance is restored.

The researchers inserted a particularly unstable protein into *Escherichia coli (E. coli)*, which forced the bacteria to either adapt by improving protein stability or die when exposed to antibiotics. Through a "directed evolution" experiment, in which the scientists selected colonies with increasing antibiotic resistance -- and

increasing protein stability -- the team generated designer bacteria that produced up to 700 times more of the previously unstable protein.

"It is exciting to realize that if even bacteria are asked in the right way, they can come up with good solutions to hard problems," said postdoctoral fellow Shu Quan, who spearheaded the work.

In looking to see why the designer bacteria were so much better at producing proteins, the scientists found that the efficient microbes were making much more of a small protein called Spy. Further study showed that the cradle-shaped Spy aids in protein refolding and protects unstable proteins from being cut up or sticking to other proteins.

"Our work may usher in an era of designer bacteria that have had their folding environment customized so that they can now efficiently fold normally unstable proteins," Bardwell said.

The work was conducted in Bardwell's lab at U-M. Mirek Cygler's laboratory at McGill University solved the structure of the Spy protein. In addition to Bardwell, Quan and Cygler, the paper's authors are masters students Philipp Koldewey and Stephan Hofmann; undergraduate students Nadine Kirsch and Jennifer Pfizenmaier; postdoctoral research associates Tim Tapley, Linda Foit and Guoping Ren; associate professor Ursula Jakob and associate professor Zhaohui Xu; all of U-M; and Karen Ruane and Rong Shi of McGill University.

The researchers received funding from Howard Hughes Medical Institute and the Canadian Institutes of Health Research.

Story Source:

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

Journal Reference:

1. Shu Quan, Philipp Koldewey, Tim Tapley, Nadine Kirsch, Karen M Ruane, Jennifer Pfizenmaier, Rong Shi, Stephan Hofmann, Linda Foit, Guoping Ren, Ursula Jakob, Zhaohui Xu, Miroslaw Cygler, James C A Bardwell. **Genetic selection designed to stabilize proteins uncovers a chaperone called Spy**. *Nature Structural & Molecular Biology*, 2011; DOI: 10.1038/nsmb.2016

http://www.sciencedaily.com/releases/2011/02/110214115450.htm

Working Toward Automating Sedation in Intensive Care Units

Georgia Tech researchers Allen Tannenbaum, Wassim Haddad and Behnood Gholami (left-right) and Northeast Georgia Medical Center chief medical informatics officer James Bailey have developed control algorithms to automate sedation in the intensive care unit. Their algorithms returned the same results as the assessment by hospital staff 92 percent of the time. (Credit: Georgia Tech/Gary Meek)

ScienceDaily (Feb. 14, 2011) — Researchers at the Georgia Institute of Technology and the Northeast Georgia Medical Center are one step closer to their goal of automating the management of sedation in hospital intensive care units (ICUs). They have developed control algorithms that use clinical data to accurately determine a patient's level of sedation and can notify medical staff if there is a change in the level.

"ICU nurses have one of the most task-laden jobs in medicine and typically take care of multiple patients at the same time, so if we can use control system technology to automate the task of sedation, patient safety will be enhanced and drug delivery will improve in the ICU," said James Bailey, the chief medical informatics officer at the Northeast Georgia Medical Center in Gainesville, Ga. Bailey is also a certified anesthesiologist and intensive care specialist.

During a presentation at the IEEE Conference on Decision and Control, the researchers reported on their analysis of more than 15,000 clinical measurements from 366 ICU patients they classified as "agitated" or "not agitated." Agitation is a measure of the level of patient sedation. The algorithm returned the same results as the assessment by hospital staff 92 percent of the time.

"Manual sedation control can be tedious, imprecise, time-consuming and sometimes of poor quality, depending on the skills and judgment of the ICU nurse," said Wassim Haddad, a professor in the Georgia Tech School of Aerospace Engineering. "Ultimately, we envision an automated system in which the ICU nurse evaluates the ICU patient, enters the patient's sedation level into a controller, which then adjusts the sedative dosing regimen to maintain sedation at the desired level by continuously collecting and analyzing quantitative clinical data on the patient."

This project is supported in part by the U.S. Army. On the battlefield, military physicians sometimes face demanding critical care situations and the use of advanced control technologies is essential for extending the capabilities of the health care system to handle large numbers of injured soldiers.

Working with Haddad and Bailey on this project are Allen Tannenbaum and Behnood Gholami. Tannenbaum holds a joint appointment as the Julian Hightower Chair in the Georgia Tech School of Electrical and Computer Engineering and the Wallace H. Coulter Department of Biomedical Engineering at Georgia Tech and Emory University, while Gholami is currently a postdoctoral fellow in the Georgia Tech School of Electrical and Computer Engineering.

This research builds on Haddad and Bailey's previous work automating anesthesia in hospital operating rooms. The adaptive control algorithms developed by Haddad and Bailey control the infusion of an anesthetic drug agent in order to maintain a desired constant level of depth of anesthesia during surgery in the operating room. Clinical trial results that will be published in the March issue of the journal IEEE Transactions on Control Systems Technology demonstrate excellent regulation of unconsciousness allowing for a safe and effective administration of an anesthetic agent.

Critically ill patients in the ICU frequently require invasive monitoring and other support that can lead to anxiety, agitation and pain. Sedation is essential for the comfort and safety of these patients.

"The challenge in developing closed-loop control systems for sedating critically ill patients is finding the appropriate performance variable or variables that measure the level of sedation of a patient, in turn allowing an automated controller to provide adequate sedation without oversedation," said Gholami.

In the ICU, the researchers used information detailing each patient's facial expression, gross motor movement, response to a potentially noxious stimulus, heart rate and blood pressure stability, noncardiac sympathetic stability, and nonverbal pain scale to determine a level of sedation.

The researchers classified the clinical data for each variable into categories. For example, a patient's facial expression was categorized as "relaxed," "grimacing and moaning," or "grimacing and crying." A patient's noncardiac sympathetic stability was classified as "warm and dry skin," "flushed and sweaty," or "pale and sweaty."

They also recorded each patient's score on the motor activity and assessment scale (MAAS), which is used by clinicians to evaluate level of sedation on a scale of zero to six. In the MAAS system, a score of zero represents an "unresponsive patient," three represents a "calm and cooperative patient," and six represents a "dangerously agitated patient." The MAAS score is subjective and can result in inconsistencies and variability in sedation administration.

Using a Bayesian network, the researchers used the clinical data to compute the probability that a patient was agitated. Twelve-thousand measurements collected from patients admitted to the ICU at the Northeast Georgia Medical Center between during a one-year period were used to train the Bayesian network and the remaining 3,000 were used to test it.

In 18 percent of the test cases, the computer classified a patient as "agitated" but the MAAS score described the same patient as "not agitated." In five percent of the test cases, the computer classified a patient as "not agitated," whereas the MAAS score indicated "agitated." These probabilities signify an 18 percent false-positive rate and a five percent false-negative rate.

"This level of performance would allow a significant reduction in the workload of the intensive care unit nurse, but it would in no way replace the nurse as the ultimate judge of the adequacy of sedation," said Bailey. "However, by relieving the nurse of some of the work associated with titration of sedation, it would allow the nurse to better focus on other aspects of his or her demanding job."

The researchers' next step toward closed-loop control of sedation in the ICU will be to continuously collect clinical data from ICU patients in real time. Future work will involve the development of objective techniques for assessing ICU sedation using movement, facial expression and responsiveness to stimuli.

Digital imaging will be used to assess a patient's facial expression and also gross motor movement. In a study published in the June 2010 issue of the journal IEEE Transactions on Biomedical Engineering, the researchers

showed that machine learning methods could be used to assess the level of pain in patients using facial expressions.

"We will explore the relationship between the data we can extract from these multiple sensors and the subjective clinical MAAS score," said Haddad. "We will then use the knowledge we have gained in developing feedback control algorithms for anesthesia dosage levels in the operating room to develop an expert system to automate drug dosage in the ICU."

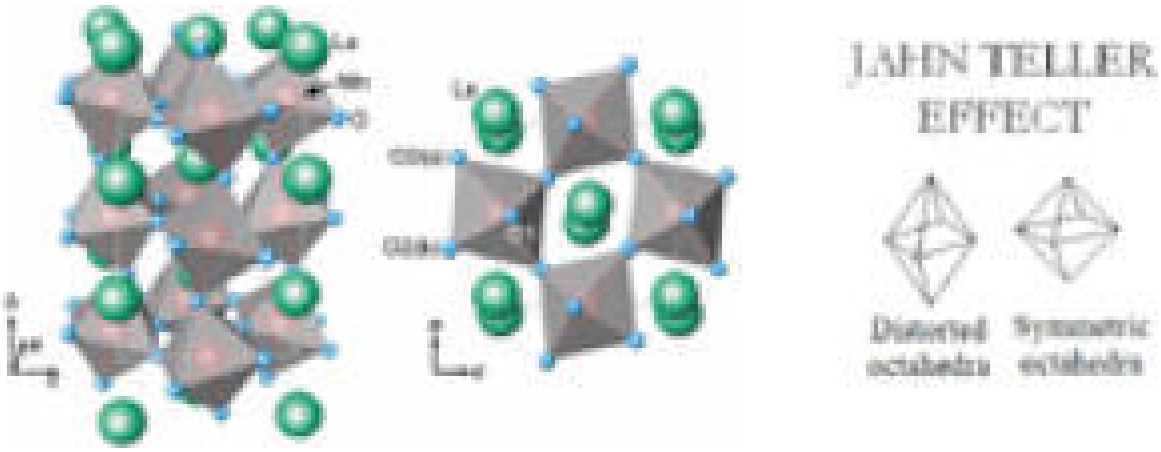
This project is supported in part by the U.S. Army Medical Research and Material Command (Grant No. 08108002).

Story Source:

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

http://www.sciencedaily.com/releases/2011/02/110214115448.htm

Delving Into Manganite Conductivity



On the left, is a picture of the structure of LaMnO3. On the right, is a diagram of how the Jahn-Teller effect distorts the structure of LaMnO3. (Credit: Image courtesy of Carnegie Institution)

ScienceDaily (Feb. 14, 2011) — Chemical compounds called manganites have been studied for many years since the discovery of colossal magnetoresistance, a property that promises important applications in the fields of magnetic sensors, magnetic random access memories and spintronic devices. However, understanding -- and ultimately controlling -- this effect remains a challenge, because much about manganite physics is still not known. A research team lead by Maria Baldini from Stanford University and Carnegie Geophysical Laboratory scientists Viktor Struzhkin and Alexander Goncharov has made an important breakthrough in our understanding of the mysterious ways manganites respond when subjected to intense pressure.

At ambient conditions, manganites have insulating properties, meaning they do not conduct electric charges. When pressure of about 340,000 atmospheres is applied, these compounds change from an insulating state to a metallic state, which easily conducts charges. Scientists have long debated about the trigger for this change in conductivity.

The research team's new evidence, published online Feb. 11 in *Physical Review Letters*, shows that for the manganite $LaMnO_3$, this insulator-to-metal transition is strongly linked to a phenomenon called the Jahn-Teller effect. This effect actually causes a unique distortion of the compound's structure. The team's measurements were carried out at the Geophysical Laboratory.

Counter to expectations, the Jahn-Teller distortion is observed until $LaMnO_3$ is in a non-conductive insulating state. Therefore, it is reasonable to believe that the switch from insulator to metal occurs when the distortion is suppressed, settling a longstanding debate about the nature of manganite insulating state. The formation of inhomogeneous domains -- some with and some without distortion -- was also observed. This evidence suggests that the manganite becomes metallic when the breakdown of undistorted to distorted molecules hits a critical threshold in favor of the undistorted.

"Separation into domains may be a ubiquitous phenomenon at high pressure and opens up the possibility of inducing colossal magnetoresistance by applying pressure" said Baldini, who was with Stanford at the time the research was conducted, but has now joined Carnegie as a research scientist.

Some of the researchers were supported by various grants from the Department of Energy, Office of Science and National Nuclear Security Administration. Some of the experiments were supported by DOE and Carnegie Canada.

Story Source:

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

Journal Reference:

1. M. Baldini, V. Struzhkin, A. Goncharov, P. Postorino, W. Mao. **Persistence of Jahn-Teller Distortion up to the Insulator to Metal Transition in $LaMnO_3$**. *Physical Review Letters*, 2011; 106 (6) DOI: 10.1103/PhysRevLett.106.066402

http://www.sciencedaily.com/releases/2011/02/110209151300.htm

Invasive Plants Can Create Positive Ecological Change

In Pennsylvania there are now three to four times more fruit-eating birds such as robins and catbirds than there were just 30 years ago, especially in landscapes of high human presence. While some invasive, human-introduced plants are definitely problematic, others could serve to restore ecological balance by providing essential food resources to native migratory birds that populate areas affected by humans. (Credit: Tomás Carlo, Penn State)

ScienceDaily (Feb. 14, 2011) — A team of scientists has discovered that human-introduced, invasive species of plants can have positive ecological effects. Tomás Carlo, an assistant professor of biology at Penn State University, and Jason Gleditsch, a graduate student in the Department of Biology, have studied how invasive fruiting plants affect ecosystems and how those effects, contrary to prevailing ideas, sometimes can be beneficial to an ecological community.

The team's research, which will be published in the journal *Diversity and Distributions*, is expected to affect the way environmental resource managers respond to ecosystem maintenance.

"Among conservation biologists, ecologists, and managers, the default approach is to try to eliminate and root out non-native, invasive shrubs -- anything that seems to change an ecosystem," Carlo said. "The fundamental goal is to return a natural area to its original, pristine state, with the native species occupying the dominant position in the community. But the problem is that most native communities already have been changed beyond recognition by humans, and many native species are now rare." Carlo explained that his team wanted to test whether certain well-established, invasive fruiting species have negative or positive effects on bird and fruiting-plant communities. "We wondered: Are we sometimes doing more harm than good when we eradicate plants that, despite being introduced recently, have formed positive relationships with native animals?" To be considered invasive, a species of plant must have been introduced by humans, and it must be dominant numerically in the new environment.

To test the impact of an invasive fruiting-plant species on native bird communities, Carlo and Gleditsch sectioned off an area of central Pennsylvania known as the Happy Valley region, where honeysuckle -- a non-native fruiting plant that is considered invasive -- grows in abundance. They then assessed the abundance of bird species and fruiting plants -- including honeysuckle -- within the area. After comparing their data with similar data from urban, agricultural, and forested areas, they determined that the abundance of honeysuckle predicted the numbers and diversity of birds within the region and even beyond the region. That is, the honeysuckle and bird communities had formed a relationship known as mutualism -- a term that describes how two or more species interact by benefiting mutually from each other's existence.

"The abundance of fruit-eating birds in the Happy Valley region is linked to the abundance of honeysuckle," Carlo explained. "Honeysuckle comprises more than half of all the fruits available in the landscape, and it benefits birds by providing them with a source of food in the fall. Meanwhile, birds benefit honeysuckle by dispersing the plant's seeds across a wider geographical area, helping the species to occupy more and more territory in areas already affected by human activities." Carlo explained that returning this particular

ecosystem to its honeysuckle-free state could harm many species of native birds that now seem to rely on honeysuckle as a major food source in the fall.

The team also tested the honeysuckle's influence, not just on birds, but on other species of fruiting plants. First, they grew native fruiting plants known as American nightshades in pots in a greenhouse. When the fruits were ripe on each plant, they then placed them into both honeysuckle-dense areas and areas area without honeysuckle but dominated by other native and non-native fruiting species. "We chose the American nightshade because it is native and common in the Happy Valley region," Carlo said. "Also, it is easy to manipulate experimentally, and its fruits are eaten -- and thus dispersed -- by native birds."

In the area in which honeysuckle grew in abundance, the rate of fruit-removal of Carlo's American nightshades was 30-percent higher than in the areas without honeysuckle. Carlo explained that in the honeysuckle-rich area, birds were present in abundance. These birds allowed the nightshades to receive more seed-dispersal services -- an ecological process known as facilitation. "The newly introduced plants piggybacked on the success of the honeysuckle, which is a common phenomenon because fruit-eating birds usually feed on a variety of fruit -- whatever happens to be available to them," Carlo explained. "The same birds that ate the honeysuckle also ate the American nightshade, dispersing the seeds of both plants. It's a win-win-win for all three: the birds, the honeysuckle, and the nightshades."

Carlo also explained that in Pennsylvania there are now three to four times more fruit-eating birds such as robins and catbirds than there were just 30 years ago, especially in landscapes of high human presence. So scientists should conclude that, while some invasive, human-introduced plants are definitely problematic, others could serve to restore ecological balance by providing essential food resources to native migratory birds that populate areas affected by humans. "Invasive species could fill niches in degraded ecosystems and help restore native biodiversity in an inexpensive and self-organized way that requires little or no human intervention," Carlo said.

In addition, Carlo explained, while eliminating an invasive species could result in harm to the newly formed balance of an ecosystem, large-scale attempts to remove species also could be a waste of time and tax dollars. He explained that when managers and agencies attempt to eradicate an invasive plant from a particular ecosystem, the species often ends up growing back anyway. "Nature is in a constant state of flux, always shifting and readjusting as new relationships form between species, and not all of these relationships are bad just because they are novel or created by humans," Carlo said. "We need to be more careful about shooting first and asking questions later -- assuming that introduced species are inherently harmful. We should be asking: Are we responding to real threats to nature or to our cultural perception and scientific bias?"Support for this research is provided by the Penn State Department of Biology and the Penn State Huck Institutes of the Life Sciences.

Story Source:

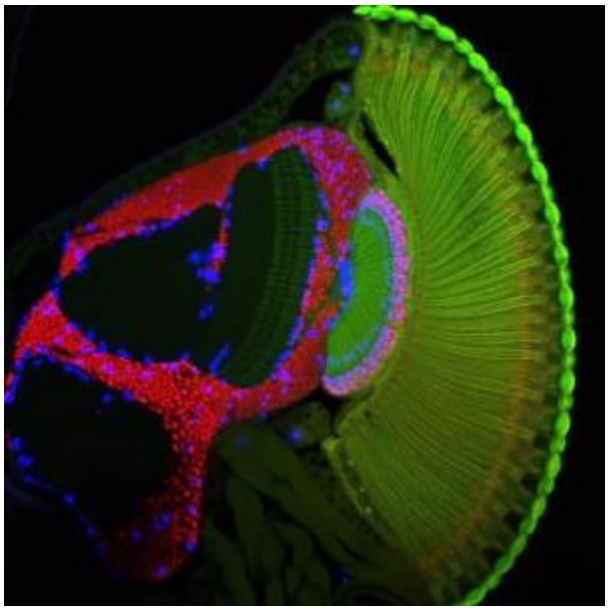
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Penn State**.

Journal Reference:

1. Jason M. Gleditsch, Tomás A. Carlo. **Fruit quantity of invasive shrubs predicts the abundance of common native avian frugivores in central Pennsylvania**. *Diversity and Distributions*, 2010; DOI: 10.1111/j.1472-4642.2010.00733.x

http://www.sciencedaily.com/releases/2011/02/110211095555.htm

Partnership of Genes Affects the Brain's Development



The photoreceptor nerve cells (green) of the fly's compound eye send their axons to the brain's optic ganglia. Scientists have now discovered that the axons are able to recognize their target area in the brain thanks to the interaction of two genes. (Credit: Max Planck Institute of Neurobiology / Suzuki)

ScienceDaily (Feb. 14, 2011) — The human brain consists of approximately one hundred billion nerve cells. Each of these cells needs to connect to specific other cells during the brain's development in order to form a fully functional organism. Yet how does a nerve cell know where it should grow and which cells to contact? Scientists of the Max Planck Institute of Neurobiology in Martinsried have now shown that growing nerve cells realise when they've reached their target area in the fly brain thanks to the interaction of two genes.

Similar mechanisms are also likely to play a role during the development of the vertebrate brain and could thus be important for a better understanding of certain developmental disorders.

The nervous system is incredibly complex. Millions and even many billion nerve cells are created during development. Each of these cells sets up connections to their neighbouring cells and then sends out a long connecting cable, the axon, to a different brain region. Once the axon has reached its target area it connects itself with the local nerve cells. In this way a processing chain is established which allows us, for example, to see a cup, recognize it as such, reach out and take hold of it. Had there been a misconnection between the nerve cells somewhere along the way between the eyes and the hand, it would be impossible to reach the coffee in the cup.

It is thus essential for nerve cells to connect to the correct partner cells. Based on this fact, scientists of the Max Planck Institute of Neurobiology in Martinsried and colleagues from Kyoto investigated how an axon knows where it should stop growing and start setting up connections with surrounding cells. For their investigation, the neurobiologists analyzed the function of genes that play a role in the development of the visual system of the fruit fly.

The scientists now report in the scientific journal *Nature Neuroscience* that the visual system of the fruit fly is only able to develop correctly, when two genes work together -- the genes, that are in charge of producing the proteins "Golden Goal" and "Flamingo." These two proteins are located at the tip of a growing axon, where they are believed to gather information about their environment from the surrounding tissue. The actions of

these two proteins enable nerve cells in a number of ways to find their way in the brain and recognize their target area. The study showed that chaos results if only one of the genes is active, or if there is a mismatch in the genes' activity: the axons cease to grow somewhere along the way and never reach their target area.

"We assume that very similar mechanisms play a role also in other organisms -- including humans," explains Takashi Suzuki, lead author of the study. "We are now a good way into understanding how to manipulate the cells in such a way that they are certain to reach their target area." This knowledge would be an important foundation for eventual therapies of developmental disorders based upon a misguided growth of nerve cells. The knowledge may also help in the guidance of regenerating nerve cells back to their old connection sites.

Story Source:

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

Journal Reference:

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The Recycled Port? An Alternative to Dumping at Sea

In search of a sustainable alternative to dumping at sea or disposal on land, a Scandinavian consortium blended contaminated sediment with a special mix of binders to produce a safe construction material for use in ports and harbours. (Credit: Image courtesy of Eureka)

ScienceDaily (Feb. 14, 2011) — In search of a sustainable alternative to dumping at sea or disposal on land, a Scandinavian consortium blended contaminated sediment with a special mix of binders to produce a safe construction material for use in ports and harbours.

Stricter regulations have reduced the use of hazardous chemicals and heavy metals in industrial activities, but their legacy lives on in the environment, notably in polluted soils and sediments. One sector where they present a particular headache is in the shipping and port industry, where dredging routinely turns up sediment contaminated with the likes of carcinogenic PCBs, TBT, cadmium, lead and mercury. Port owners are caught between constraints on dumping sediment at sea, the cheap but polluting option, and removing it to be treated for landfill, an expensive alternative.

Enter a recent EUREKA project, STABCON, in which a Swedish-Norwegian consortium -- of research bodies, binder manufacturers, port authorities and design consultants -- sought to adapt the 'stabilisation and solidification' method to treat polluted sediments and other dredged material commonly found in Scandinavia.

Having worked together on an earlier study into the potential of the stabilisation and solidification technique in Sweden for the country's environment protection agency, the project participants teamed up to test the method in a pilot study and draw up guidelines for ports.

A cost-effective solution

Led by Merox, a subsidiary of Swedish steelmaker Svenskt Stål AB (SSAB), they first compared the three alternatives for handling sediments -- dumping, solidification and stabilisation, and dredging and disposing on land -- from a sustainability perspective. Stabilisation and solidification proved to be a sustainable and cost-effective solution. Contaminated sediments are mixed, on site, with products that bind it to create a solid material that contains the hazardous substances.

As well as being more environmentally friendly than dumping and cheaper than landfilling, "this method offers a number of additional benefits," explained Göran Holm, R&D director of the Swedish Geotechnical Institute, one of the project partners. "It reduces the demand for natural resources, such as blasted rock; and by treating the sediments in situ and using them in port areas, the need for transport is reduced, along with the associated health risks."

Supported by funding from EUREKA member countries, the project partners conducted tests in a pilot project to identify the most suitable binder composition and ideal mixing procedure for a variety of contaminants and sediment types. Researchers observed the behaviour of the treated sediment for leakage, permeability,

strength and durability. The binder they used was a mixture of cement and a Merox product, Merit 5000, a derivative from the steel-making process. The slag is able to bind heavy metals chemically at the same time as it cures.

Putting it to the test

The final step of the project translated the results into a report and guidelines for port authorities, to enable them to assess options for using stabilisation and solidification and select the best binder for their local conditions, while providing design principles for using treated sediments in harbour structures, such as paved areas, loading zones and buildings. The STABCON test site was the Swedish port of Oxelösund, itself a partner in the project. The port wanted to build a new harbour area, and needed to remove contaminated sediment while at the same time respecting Sweden's strict environmental regulations.

Its aim was to dredge a section of harbour and treat the sediment for use in the new land area. The team dredged about 500 cubic metres of soft sediment, and strengthened it with a mix of cement and Merit 5000. They placed the composition on gravel and sand, and studied its properties, taking samples and conducting laboratory tests for leakage, including in nearby waters. The results were impressive. Once stabilised, there was no degradation from a chemical point of view, and no physical damage either.

The new material also passed the test for durability. "We are pretty confident that it will last for the long term," said Therese Stark, a research and development engineer at Merox. "The main thing is to keep the sediments in as natural an environment as possible, which you can't do if you take them away to deposit elsewhere. We are trying to keep them as they were in the ocean." Key to the outcome of the project was a close working relationship between partners and the expertise that each brought to the table.

An expanding market

"The work was very successful. We had a very strong consortium," reflected Göran Holm. "It included manufacturers of binders, like Merox and Cementa, research organisations, consultancies that took charge of design, a harbour with polluted sediment and contractors that performed the test." Working in symbiosis, the research bodies gained expertise in the technical and environmental area, and in support for decision-making, while the industrial partners gained insight into how their products could be used to greater effect: "We all have a lot more knowledge about how to treat sediments with proportions of binders for different pollutants," says Therese Stark of Merox.

The project has already translated into new contracts for the participants. A number of ports in Sweden have taken a keen interest in the cost-effective 'stabilisation and solidification' method, and many are undertaking tests with their own sediments, consulting STABCON partners for their know-how. Meanwhile, a more extensive R&D project has been launched for the whole Baltic Sea region, thanks partly to the work achieved by STABCON.

Story Source:

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

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http://www.sciencedaily.com/releases/2011/02/110209082630.htm

Heat Therapy Could Be New Treatment for Parasitic Skin Disease

Top, lesions on the patient's hand before the start of heat therapy. Bottom, the same lesions showing complete healing with minimal scarring one year after treatment. (Credit: The Lancet)

ScienceDaily (Feb. 14, 2011) — Scientists are hoping that heat therapy could eventually replace a complex drug regimen as the first-line treatment of a parasitic skin infection common in tropical and subtropical regions of the world.

The researchers successfully treated the skin infection with heat therapy in two patients whose immune systems were deficient, which lowered their bodies' ability to respond to medication. Both patients have remained free of the parasitic disease, called cutaneous leishmaniasis, for more than a year since receiving the heat treatment.

That long-term effectiveness, especially in people with compromised immune systems, makes this one-time application of heat to skin lesions an appealing alternative to the conventional treatment for the infection -- a series of about 20 consecutive daily drug injections that is rife with compliance problems, researchers say.

The case report about these treatments is published in the Feb. 12 issue of *The Lancet*.

"The fact that this treatment worked in immune-compromised people over the long term means it should work in healthy people, and could become the first-line treatment," said Abhay Satoskar, professor of pathology at Ohio State University and senior author of the *Lancet* case report.

Additional research on multiple patients would be required to substantiate the heat treatment's effectiveness and confirm its potential to replace drug therapy, he noted.

"If this same level of efficacy can be proved in the long term, it could revolutionize the management of cutaneous leishmaniasis in the world," he said.

This heat therapy worked on the form of the infection that attacks the skin, which is characterized by sores of various sizes that may or may not be painful. An estimated 1.5 million new cases of cutaneous leishmaniasis are diagnosed each year worldwide, according to the U.S. Centers for Disease Control and Prevention (CDC).

This therapy would not apply to the less-common visceral form of the disease that affects internal organs, or the even rarer form, mucosal leishmaniasis, which affects the mouth, nose and throat. All forms of the disease are caused by infection with Leishmania parasites, which are transmitted by the bite of infected sand flies.

According to the CDC, more than 90 percent of the cases of cutaneous leishmaniasis occur in parts of Afghanistan, Algeria, Iran, Iraq, Saudi Arabia, Syria, Brazil and Peru. The disease is rare in the United States, but it is showing up in border states and also affects U.S. soldiers deployed to the Middle East.

Satoskar and colleagues described the case of a 34-year-old man in Rajasthan, India, who was diagnosed in January 2009 with cutaneous leishmaniasis and HIV infection. In addition to treating his HIV, clinicians gave him twice-weekly injections of sodium stibogluconate, a commonly used compound for the skin disease, for six weeks. After 24 weeks, the leishmaniasis sores were still present.

At this point, the clinicians treated each skin sore with a single application of radio-frequency-induced heat therapy for 60 seconds under local anesthesia. He was prescribed an oral anti-inflammatory and antibiotic skin cream to treat wounds caused by the heat. The parasitic sores responded to the heat therapy, completely healing within 12 weeks. A year later, minor scars were visible where the treatments had occurred.

The therapy works by delivering radio frequencies that excite tissue molecules, producing heat that penetrates the top layer of skin and destroys diseased tissue underneath, Satoskar said.

The standard compounds used to treat cutaneous leishmaniasis, called antimonials, must be given by injection and can cause damage to veins and other unpleasant symptoms, such as nausea, vomiting or diarrhea, muscle or joint pain, and dizziness. These side effects, combined with the need to receive daily shots for three weeks, lead to poor patient compliance -- which can then allow the parasites to develop resistance to the drugs.

Previous studies have shown that radio-frequency-induced heat can be effective in treating this skin disorder, but it had not been tested before in a patient with a compromised immune system, Satoskar said. "Patients need a normal immune system for the leishmaniasis drugs to work," he said.

He added that patients in previous studies also had not been followed for as long as a year.

The second HIV-infected patient described briefly in the report had cutaneous leishmaniasis sores that did not respond to the conventional sodium stibogluconate regimen or a follow-up antibiotic treatment. The 28-year-old man also remained disease-free one year after he received radio-frequency-induced heat therapy.

The equipment used for heat therapy currently costs approximately $14,000, and is portable so it could be used in rural environments. "That way, you don't need patients to come to a clinic, making this much easier to use in the field," Satoskar said.

He predicted that if the treatment were widely adopted, the cost of the equipment would drop.

Satoskar has received a $2.7 million grant from the National Institutes of Health to conduct additional research in an effort to identify new drug therapies for leishmaniasis.

Co-authors of this case report include Neha Prasad, Bhikam Ghiya and Ram Bumb of the Sardar Patel Medical College, Bikaner, in Rajasthan, India; Himanshu Kaushal and Poonam Salotra of the Safdarjung Hospital Campus in New Delhi, India; and Anjali Satoskar and Claudio Lezama-Davila of Ohio State's departments of Pathology and Microbiology.

This work was supported by a grant from Thermosurgery Inc. based in Phoenix, which manufactures the radio-frequency generator used in the study. Satoskar has no affiliation with the company beyond its support of this research.

Story Source:

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

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Airborne Sensor to Study 'Rivers in the Sky'

NASA's Global Hawk soars aloft from Edwards Air Force Base, Calif., on a functional check flight of the WISPAR aircraft payload system and science instruments. (Credit: NASA Dryden Flight Research Center)

ScienceDaily (Feb. 14, 2011) — They're called atmospheric rivers -- narrow regions in Earth's atmosphere that transport enormous amounts of water vapor across the Pacific or other regions. Aptly nicknamed "rivers in the sky," they can transport enough water vapor in one day, on average, to flood an area the size of Maryland 0.3 meters (1 foot) deep, or about seven times the average daily flow of water from the Mississippi River into the Gulf of Mexico. The phenomenon was the subject of a recent major emergency preparedness scenario led by the U.S. Geological Survey, "ARkStorm," which focused on the possibility of a series of strong atmospheric rivers striking California -- a scenario of flooding, wind and mudslides the USGS said could cause damages exceeding those of Hurricane Katrina in 2005.

While atmospheric rivers are responsible for great quantities of rain that can produce flooding, they also contribute to beneficial increases in snowpack. A series of atmospheric rivers fueled the strong winter storms that battered the U.S. West Coast from western Washington to Southern California from Dec. 10 to 22, 2010, producing 28 to 64 centimeters (11 to 25 inches) of rain in certain areas. The atmospheric rivers also contributed to the snowpack in the Sierras, which received 75 percent of its annual snow by Dec. 22, the first full day of winter.

To improve our understanding of how atmospheric rivers form and behave and evaluate the operational use of unmanned aircraft for investigating these phenomena, NASA scientists, aircraft and sensors will participate in a National Oceanic and Atmospheric Administration-led airborne field campaign slated to begin Feb. 11.

Called Winter Storms and Pacific Atmospheric Rivers, or WISPAR, the field campaign, which continues through the end of February, is designed to demonstrate new technology, contribute to our understanding of atmospheric rivers and assist NOAA in potentially conducting offshore monitoring of atmospheric rivers to aid in future weather predictions.

A NASA Global Hawk unmanned aircraft operated out of NASA's Dryden Flight Research Center in Southern California is scheduled to depart Dryden Friday morning, Feb. 11, on the campaign's first science

flight. The 24-hour flight will study an atmospheric river currently developing in the Pacific Ocean off Hawaii that appears as though it will impact the Oregon-California coast this weekend. Aboard the Global Hawk will be new weather reconnaissance devices called dropsondes developed by the National Center for Atmospheric Research that will take temperature, wind and other readings as they descend through an atmospheric river. Also aboard will be an advanced water vapor sensor -- the High-Altitude Monolithic Microwave Integrated Circuit Sounding Radiometer, or HAMSR -- created by NASA's Jet Propulsion Laboratory in Pasadena, Calif.

The remote-sensing HAMSR instrument analyzes the heat radiation emitted by oxygen and water molecules in the atmosphere to determine their density and temperature. The instrument operates at microwave frequencies that can penetrate clouds, enabling it to determine temperature, humidity and cloud structure under all weather conditions. This capability is critical for studying atmospheric processes associated with bad weather, like the conditions present during atmospheric river events.

HAMSR Principal Investigator Bjorn Lambrigtsen of JPL says the instrument -- the most accurate and sensitive of its kind in the world -- will help scientists better understand these unique weather phenomena.

"The WISPAR campaign is intended to study the concentrated streams of tropical moisture that sometimes get connected with cold fronts and winter storms approaching the U.S. West Coast -- sometimes called the pineapple express, since they often originate near Hawaii -- which can result in very intense rain events," Lambrigtsen said. "HAMSR, flying on NASA's unpiloted Global Hawk well above the weather but close enough to get a much more detailed picture than is possible from a satellite, will be used to map out this phenomenon and answer scientific questions about the formation and structure of these systems."

NASA's Global Hawk is an ideal platform from which to conduct WISPAR science because it is able to fly long distances, stay aloft for more than 24 hours and travel at high and low altitudes that could be dangerous for humans. Lambrigtsen will be at Dryden in the Global Hawk Operations Center during the flights, using data from the sensor and other information to adjust the Global Hawk's flight track, as necessary, to optimize the sampling of the atmospheric rivers.

Lambrigtsen said the public can monitor the progress of the WISPAR science flights in real time on a WISPAR version of JPL's hurricane portal website at http://winterscience.jpl.nasa.gov/WISPAR2011/ . The site will display the most recent satellite images, the Global Hawk flight track and a real-time subset of HAMSR data.

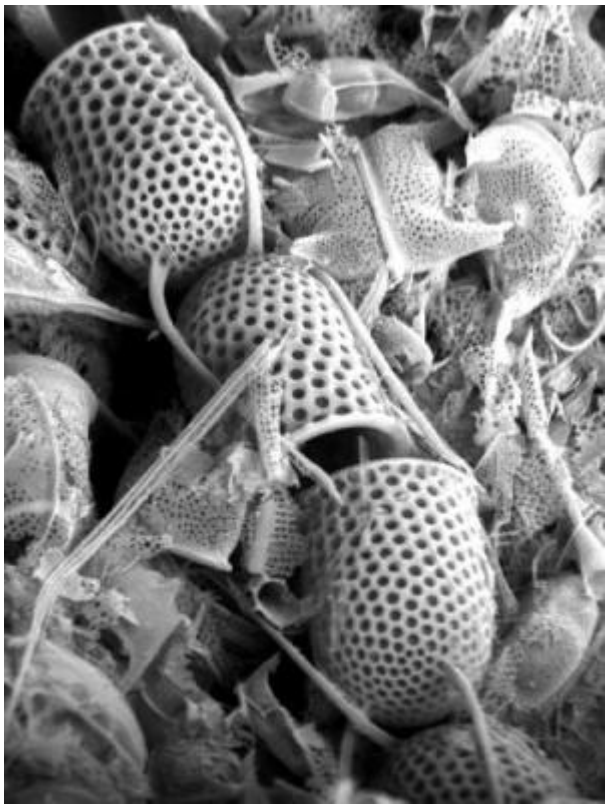
For more information about WISPAR, visit: http://www.noaanews.noaa.gov/stories2011/20110210_atmosphericrivers.html . For more on HAMSR, see: http://microwavescience.jpl.nasa.gov/instruments/hamsr/ .

Story Source:

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

http://www.sciencedaily.com/releases/2011/02/110211202025.htm

Arctic Climate Variation Under Ancient Greenhouse Conditions



Studying the fossilized remains of diatoms in sediments tell us a great about past climate. (Credit: Andrew Davies, Alan Kemp and Heiko Pälike)

ScienceDaily (Feb. 14, 2011) — Tiny organisms preserved in marine sediments hold clues about Arctic climate variation during an ancient episode of greenhouse warming.

Based on reconstructions of Arctic climate variability in the greenhouse world of the Late Cretaceous, Southampton scientists have concluded that man-made global warming probably would not greatly change the climatic influence associated with natural modes of inter-annual climate variability such as the El Niño -- Southern Oscillation (ENSO) or the Arctic Oscillation/ North Atlantic Oscillation (AO/ NAO).

"Even in the warm Cretaceous period, the patterns of these climatic oscillations changed over longer decadal timescales," explained Professor Alan Kemp of the University of Southampton's School of Ocean and Earth Science based at the National Oceanography Centre, Southampton. "It is therefore difficult to predict whether anthropogenically driven warming will lead to systematic changes such as persistently milder European winters (a positive AO/ NAO) as some have suggested."

It is anticipated that the Arctic Ocean will become ice free during the summer within the next 15-50 years as a result of global warming. Because sea ice is reflective, its loss will reduce the amount of the Sun's energy bounced back out to space, thereby amplifying regional warming. However, changes in atmospheric circulation could also occur, making it difficult to unravel the likely net effect on climate.

"A key question is how an Arctic without permanent ice cover will affect atmospheric circulation and climate variability, particularly over high and mid latitudes," said Kemp.

One way of addressing this issue is to look back at previous greenhouse episodes in Earth's history. For example, Kemp's group has previously reported in the journal *Nature* that during the Late Cretaceous, when the dinosaurs roamed the world, the Arctic Ocean was free of ice in summer with only intermittent sea ice in the winter.

"Understanding Late Cretaceous climate should inform debate about future climate trends and variability under greenhouse conditions," said Kemp, whose team's new findings are published in *Geophysical Research Letters*.

In both studies, Kemp and his collaborators analysed sediment cores from a marine ridge in the Arctic Ocean. These sediments date to the Late Cretaceous (69-76 million years ago) and contain fossil remains of diatoms, an important group of phytoplankton -- tiny planktonic marine plants.

The sediments contain alternating band-like laminae of two types, representing diatom growth conditions in the Arctic spring and summer, respectively. Each year is represented by a couplet of laminae, one of each type, which allowed the researchers to reconstruct ocean conditions at annual resolution.

"The presence of diatom laminae testify to ice-free Arctic summers during the Late Cretaceous, although there is also evidence of ice rafting by intermittent winter ice," said Kemp.

The researchers analysed two sections of sediment core covering between them a continuous period of around 1,000 years. By analysing the characteristics of the diatom laminae and measuring their thickness they were able to reconstruct climate-driven variation in ocean conditions both between years and over decades.

Their analyses revealed that the Arctic climate of the Late Cretaceous varied over various timescales with periodicities closely matching those observed in the modern Arctic. It therefore appears that the Arctic was subject to some of the same climatic influences in the Late Cretaceous as it is today, including ENSO, which periodically transmits equatorial influences to high-latitudes via ocean-atmosphere interactions.

"A modern Arctic lacking permanent sea ice should be subject to similar influences as it was under greenhouse conditions in the Late Cretaceous," said Kemp.

This is important because there has been an ongoing debate about whether natural modes of climate variability such as ENSO and AO/ NAO would be perturbed or enhanced by global warming caused by greenhouse gas emissions. Particular controversy has surrounded whether such warming could cause a permanent El Niño state or milder European winters.

"Based on our findings, it seems unlikely that man-made global warming would cause a permanent El Niño state," concluded Kemp.

The researchers are Andrew Davies, Alan Kemp, and Heiko Pälike of the University of Southampton's School of Ocean and Earth Science based at the National Oceanography Centre, Southampton.

The research was funded by the Natural Environment Research Council.

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **National Oceanography Centre, Southampton (UK)**.

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3-D Movies on Your Cell Phone

MWC 2011: 3-D films on your cell phone. (Credit: Image courtesy of Fraunhofer-Gesellschaft)

ScienceDaily (Feb. 14, 2011) — Researchers at Fraunhofer have combined the new mobile radio standard LTE-Advanced with a video coding technique. The technology promises to put 3-D movies on your cell phone.

The experts will be presenting their solution from February 14-17 at the Mobile World Congress in Barcelona.

Halting page loading and postage stamp sized-videos jiggling all over the screen -- those days are gone for good thanks to Smartphones, flat rates and fast data links. Last year, 100 million videos were seen on YouTube with cell phones all over the world.

A survey of the high-tech association BITKOM found that 10 million people surf the Internet with their cell phones in Germany. And there's another hype that is unbroken: 3-D movies. Researchers at the Fraunhofer Institute for Telecommunications, Heinrich-Hertz-Institut, HHI in Berlin, Germany, have been able to put both of them together so you can experience mobile Internet in three dimensions.

The researchers have come up with a special compression technique for movies in especially good high-resolution HD quality. It computes the movies down to low data rates while maintaining quality: H.264/AVC. What the H.246/AVC video format is to high-definition movies, the Multiview Video Coding (MVC) is to 3-D movies. Thomas Schierl is a scientist at the HHI, and he explained that "MVC is used to pack together the two images needed for the stereoscopic 3-D effect to measurably reduce the film's bit rate," and this technique can be used to reduce the size of 3-D movies as much as 40 percent.

That means that you can quickly receive excellent quality 3-D movies in connection with the new 3G-LTE mobile radio standard. Key is the radio resource management integrated into the LTE system that allows flexible data transmission while including various quality of service classes. Thomas Wirth, another scientist at the HHI, explains further: "The 2-D and 3-D bit streams divided up by MVC can be prioritized for each user at the air interface to support different services, thus opening up a completely new field for business models." Premium services for instance, where only the paying user can watch the 3-D version of the movie. Also a 3-D quality guarantee, even in unfavorable reception conditions like in a driving car, is possible. That means that kids can still watch Ice Age in 3-D without interruption in the back seat of the car.

Story Source:

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http://www.sciencedaily.com/releases/2011/02/110211074747.htm

Rising Seas Will Affect Major US Coastal Cities by 2100, New Research Finds

This map shows where increases in sea level could affect the southern and Gulf coasts of the US. The colors indicate areas along the coast that are elevations of 1 meter or less (russet) or 6 meters or less (yellow) and have connectivity to the sea. (Credit: Jeremy Weiss, University of Arizona.)

ScienceDaily (Feb. 14, 2011) — Rising sea levels could threaten an average of 9 percent of the land within 180 U.S. coastal cities by 2100, according to new research led by University of Arizona scientists.

The Gulf and southern Atlantic coasts will be particularly hard hit. Miami, New Orleans, Tampa, Fla., and Virginia Beach, Va. could lose more than 10 percent of their land area by 2100.

The research is the first analysis of vulnerability to sea-level rise that includes every U.S. coastal city in the lower 48 with a population of 50,000 or more.

The latest scientific projections indicate that by 2100, the sea level will rise about 1 meter -- or even more. One meter is about 3 feet.

At the current rate of global warming, sea level is projected to continue rising after 2100 by as much as 1 meter per century.

"According to the most recent sea-level-rise science, that's where we're heading," said lead researcher Jeremy L. Weiss, a senior research specialist in the UA's department of geosciences. "Impacts from sea-level rise could be erosion, temporary flooding and permanent inundation."

The coastal municipalities the team identified had 40.5 million people living in them, according to the 2000 U.S. Census. Twenty of those cities have more than 300,000 inhabitants.

Weiss and his colleagues examined how much land area from the 180 municipalities could be affected by 1 to 6 meters of sea-level rise.

"With the current rate of greenhouse gas emissions, the projections are that the global average temperature will be 8 degrees Fahrenheit warmer than present by 2100," said Weiss, who is also a UA doctoral candidate in geosciences.

"That amount of warming will likely lock us into at least 4 to 6 meters of sea-level rise in subsequent centuries, because parts of the Greenland and Antarctic ice sheets will slowly melt away like a block of ice on the sidewalk in the summertime."

At 3 meters (almost 10 feet), on average more than 20 percent of land in those cities could be affected. Nine large cities, including Boston and New York, would have more than 10 percent of their current land area threatened. By 6 meters (about 20 feet), about one-third of the land area in U.S. coastal cities could be affected.

"Our work should help people plan with more certainty and to make decisions about what level of sea-level rise, and by implication, what level of global warming, is acceptable to their communities and neighbors," said co-author Jonathan T. Overpeck, a UA professor of geosciences and of atmospheric sciences and co-director of UA's Institute of the Environment.

Weiss, Overpeck and Ben Strauss of Climate Central in Princeton, N.J., are publishing their paper, "Implications of Recent Sea Level Rise Science for Low-Elevation Areas in Coastal Cities of the Conterminous U.S.A.," in *Climatic Change Letters*.

Weiss and Overpeck had previously developed maps of how increases in sea level could affect the U.S. coastline. Strauss suggested adding the boundaries of municipalities to focus on how rising seas would affect coastal towns and cities.

For the detailed maps needed for the new project, the researchers turned to the National Elevation Dataset produced by the U.S. Geological Survey. The NED provides a high-resolution digital database of elevations for the entire U.S.

The high resolution let Weiss and his colleagues identify the elevation of a piece of land as small as 30 meters (about 100 feet) on a side -- about the size of an average house lot.

The researchers used the USGS database to create detailed digital maps of the U.S. coast that delineate what areas could be affected by 1 meter to 6 meters of sea-level rise. The researchers also added the boundaries for all municipalities with more than 50,000 people according to the 2000 U.S. Census.

To increase the accuracy of their maps, the team included all pieces of land that had a connection to the sea and excluded low-elevation areas that had no such connection. Rising seas do not just affect oceanfront property -- water moves inland along channels, creeks, inlets and adjacent low-lying areas.

"Ours is the first national-scale data set that delineates these low-lying coastal areas for the entire lower 48 at this degree of spatial resolution," Weiss said.

The NED data set has some uncertainty, particularly for estimating elevation changes of 1 meter or less. That means the researchers' ability to identify the threat to any particular small piece of land is better for larger amounts of sea-level rise than for smaller amounts of sea-level rise, Weiss said.

"As better digital elevation models become available, we'll be using those," Weiss said. "The USGS is always improving the digital elevation models for the U.S."

Overpeck said, "The main point of our work is to give people in our coastal towns and cities more information to work with as they decide how to deal with the growing problem of sea-level rise."

Story Source:

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

http://www.sciencedaily.com/releases/2011/02/110215081742.htm