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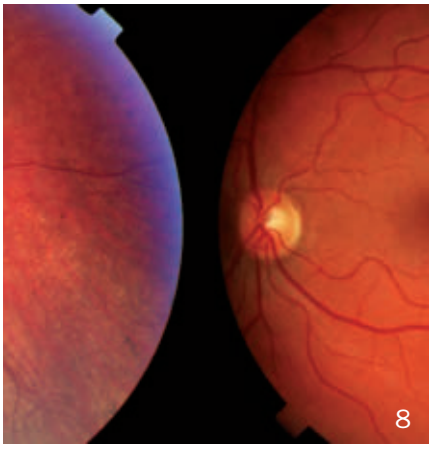

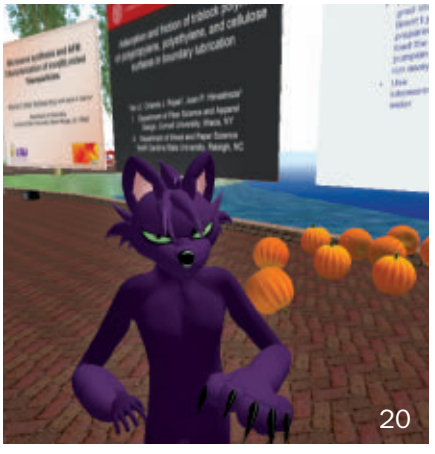

METROPOLITAN MUSEUM OF ART; T. QUESTI; J. BENNETT; CORBY WASTE/NASA-JPL

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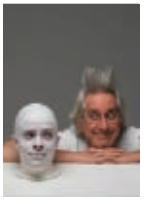
ScienceNews

In the News

Features

Departments



CARY WOLINSKY

On the cover:
"Shelflife" is from an ongoing collaboration between photographer Cary Wolinsky (right) and Triiibe artists Alicia, Kelly and Sara Casilio, who are triplets.

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Editorial, Advertising & Business Offices
1719 N Street NW,
Washington, DC 20036
Phone (202) 785-2255
scinews@sciencenews.org
Letters: editors@sciencenews.org

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FROM THE EDITOR

Keep your eye on the mouse

In the ancient world of analog media, only the news that fits gets into print. That's especially tragic in the realm of science, where there's more and more news than ever, and less and less space for it in traditional print publications.

Science News is, of course, a traditional print publication, constrained by the costs of paper and the 24-hour limit on how much editing can be done in a day (the writers here, if unleashed, would easily write far more than space and editing time would allow). But like other ink-on-paper enterprises, *Science News* can now offer more news, sooner, by straddling the analog-digital divide.

Unlike some publications, which have distinct online and print personnel, the writing and editing staffs for the *Science News* website and magazine are the same. Our website's news stories are almost always written by *Science News* staff writers, specialists in their subject areas, not by generalist all-purpose Web writers. Our reporters are eager to write what they find out on their beats without delay, and they find out a lot — far more than the magazine can hold.

Consequently most of the news in the magazine now originates as stories posted online as soon as they are ready for publication. Typically several new stories appear on the website each day, adding up in two weeks to far more than will fit in the magazine. Many of the stories that do make it into print end up substantially shortened.

Feature articles, which usually become available on the Web at the same time as the print edition, generally appear at the same length in the magazine as online.

For news stories, though, the Web often has more to offer. To signal to you which stories in print originally included more information, we add a little mouse icon to the end (). By going to www.sciencenews.org, and clicking on the appropriate topic button, you should be able to find the longer version of the story — sometimes an additional explanatory paragraph or two, sometimes considerably more.

You will also, of course, find many more articles on the topic you choose — those that were worth writing even though they didn't fit in the space available on paper. By perusing the various topic pages, you'll get just a taste of how much more science news there could be in a perfect world where all the paper publications reported nothing but science.

—Tom Siegfried, Editor in Chief

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Inform. Educate. Inspire.

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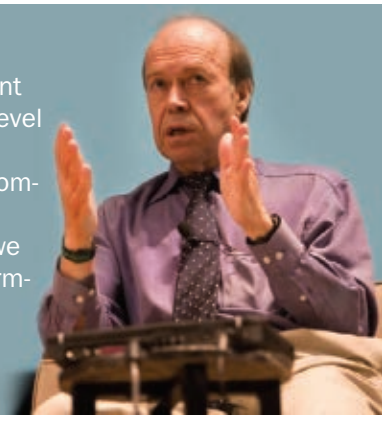
Scientific Observations



"Our home planet is dangerously near a tipping point at which human-made greenhouse gases reach a level where major climate changes can proceed mostly under their own momentum.... The upshot of the combination of inertia and feedbacks is that additional climate change is already 'in the pipeline': even if we stop increasing greenhouse gases today, more warming will occur."—JAMES HANSEN, "PERSPECTIVE OF A CLIMATOLOGIST," IN THE 2008–2009 *STATE OF THE WILD* COMPILED BY THE WILDLIFE CONSERVATION SOCIETY

Science Past: 50 Years Ago

From *Science News Letter*, May 24, 1958

ANCIENT SKULL PUZZLES— The 45,000-year-old Neanderthal skull recently assembled from fragments found in Shanidar Cave in Iraq presents a real scientific puzzle to anthropologists because, although his face was very primitive, the back of his head was more like modern man. The description of Shanidar Man as a being who appeared to be a totally different creature depending on whether he was seen coming or going was presented to the American Association of Physical Anthropologists meeting in Cambridge, Mass., by Dr. T. Dale Stewart of the Smithsonian Institution.... Putting the tiny pieces together was a super-difficult jigsaw puzzle, but Dr. Stewart reported he was able to fit them together so neatly that he satisfied himself they were all originally parts of the same individual skull. "The skull belonged to quite a different being from any modern man whose bones I have examined," Dr. Stewart told his colleagues.

Science Future

Through June 15

"Darwin's Garden: An Evolutionary Adventure," at the New York Botanical Garden. Visit **www.nybg.org.**

September 27

Scheduled opening of Ocean Hall at the Smithsonian National Museum of Natural History in Washington, D.C. Visit **www.mnh.si.edu/exhibits/ocean_hall**

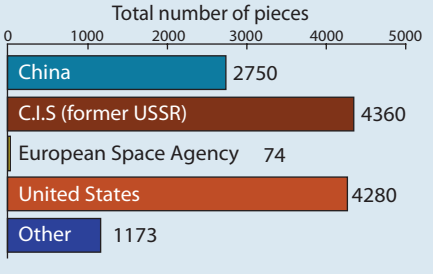
2009

International Year of Astronomy, a UNESCO and International Astronomical Union initiative. Visit **www.astronomy2009.org.**

Science Stats

THE LOWDOWN ON SPACE JUNK

Debris litters the space around Earth. Dots represent pieces left when rockets and the things they carry explode, collide or weather over time.



SOURCE: NASA ORBITAL DEBRIS PROGRAM OFFICE AS OF APRIL 2

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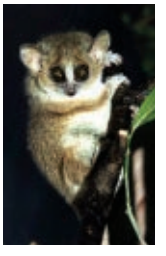
SCIENCE & THE PUBLIC

"New Orleans, at the end of the century, will be an island"—literally, predicted Bruce Babbitt, former secretary of the interior, in a talk covered in Janet Raloff's May 5 post. The city won't wash away, he said, but "much like Venice," its survival will depend on high, dikelike walls. Read more from the frontiers of science and policy in Blogs.

SIGHTS & SOUNDS

My, what big eyes you have. In S&S, reporter Rachel



Ehrenberg writes on how look-alike lemurs on Madagascar find mates with song.

SCIENCE NEWS FOR KIDS

Need a primer on climate change for your middle schooler? Read a two-part series about global warming and what can be done about it—and check out more stories aimed at a younger audience—at www.sciencenews.org/sciencenewsforkids.

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NASA JOHNSON SPACE CENTER; TIHO HANNOVER; ED KASHI

"Food miles alone are not a reliable indicator of environmental impact." —RICH PIROG, PAGE 11

In the News

STORY ONE

Searching for habitability on the Red Planet

Phoenix will dredge the Martian landscape with its robotic arm and onboard instruments

Phoenix is scheduled to land on Mars on May 25, probably on a well-mapped, flat plain thought to be dense with subsurface ice.

ILLUSTRATION BY CORBY WASTE/NASA-JPL

By Ron Cowen

A NEW EMISSARY FROM EARTH IS SET TO parachute onto Mars on May 25, making it the first craft to land on the Red Planet's north polar region and the first since the 1970s built to find life-friendly places.

NASA's $386-million Phoenix Mars Lander features a robotic arm—similar to a backhoe—that will dig trenches up to half a meter deep in the frigid soil, scraping and scooping up samples of ice that previous satellite studies indicate lie just a few centimeters beneath the surface. Phoenix will deliver those samples to onboard detectors—eight miniature ovens, four laboratory wet cells and a mass spectrometer—to determine if the region contains water, complex organic compounds and sources of energy that might support life.

The main question the craft seeks to answer: "Is there any place on Mars at all where life could exist today?" says Phoenix principal investigator Peter Smith of the University of Arizona in Tucson.

"Phoenix represents a significant step in understanding water on Mars," notes planetary scientist Jack Mustard of Brown University in Providence, R.I. In following up on the discovery by the Mars Odyssey mission of water-ice just beneath the polar surface, Phoenix will "quantitatively analyze the mineral and volatile constituents of the soil," he says. "It will also measure isotopes of carbon, oxygen, hydrogen and nitrogen, which will be unique and important measurements for understanding processes relevant to habitability."

Phoenix got its moniker because it inherited instruments from the Mars Surveyor Lander, canceled in 2000, as well as detectors similar to those on the Mars Polar Lander, lost in 1999. Scheduled to land at 68° N, the same latitude as northern Alaska, Phoenix will function for three months but might last twice as long, until the shorter, colder days of winter hamper the solar-powered craft. »

For today's top science news, visit SN Today at **www.sciencenews.org**

In searching for an existing habitat on the Red Planet, Phoenix revives an endeavor attempted with the 1976 Viking missions. "Viking made the assumption that there was life on Mars, and they were going to characterize that life," Smith says. In contrast to Viking, Phoenix takes more of a generalist approach. "We don't assume there is life, we are just looking for a habitable zone," Smith says. "We don't measure DNA. We don't measure proteins."

Mustard notes that Mars' "nasty radiation environment" makes the likelihood next to nil that life is present in the near surface. "It's best to build first towards habitability — when, where and how — and then move toward life detection on the basis of those results," he says. Phoenix "is not sexy in that it does not look for microbes, but it's very important."

To seek actual life, Smith says, a future, more sophisticated craft will require a drill that can penetrate the ice down to a depth of 20 to 30 meters, Mustard says. "Phoenix sets the stage for those future missions."

Phoenix's ovens, each about the size of a ballpoint pen's ink cartridge, will slowly heat ice samples up to 1,000° Celsius. In contrast, Viking flash-heated material to 500° C. The expanded temperature range is critical for identifying various organic compounds and monitoring the transition from solid to liquid to gas, Smith notes.

Those materials that vaporize at temperatures from about 300° C to 600° C "could be the complex organic compounds we're looking for," Smith says. Vaporization at higher temperatures may signify organic compounds delivered to the Martian surface by asteroids or comets. The gases will then be fed into a mass spectrometer, which will measure the concentration of specific atoms and molecules at concentrations as low as 10 parts per billion.

The robotic arm will also deliver single soil samples to each of four pre-warmed beakers that contain a soaking solution. After a day of stirring, soaking and measuring the beaker's contents, the sample will be frozen overnight. Upon thawing, the sample will be exposed to reagents that can test for carbonates and sulfates.

Unique to Phoenix is a robotic arm that will dig just below hard soil, where satellite measurements indicate ice resides.

In addition to digging and analyzing soil and ice samples, Phoenix's instruments will offer a commanding and highly detailed view of its landing site. "The surface itself may be absolutely fascinating without doing anything but just looking at it," Smith says.

Like a pair of eyes, twin cameras atop the craft's 2-meter-long mast will take a 3-D infrared and visible-light panorama of the arctic terrain to reveal features as small as a few millimeters across. Optical and atomic force microscopes will take close-ups of soil and water-ice samples, recording features as small as one-hundredth the width of a human hair — the tiniest details ever taken on the Red Planet.

"That's the kind of imaging I'm thinking about these days — the whole picture," from kilometers to about 100 nanometers, Smith says. "I don't know what Mars is going to offer us, and we've protected ourselves by bringing a lot of instruments that can open up the story."

Shooting infrared and green lasers into the Martian atmosphere, Phoenix will also examine the atmosphere's density and composition up to 20 kilometers in altitude. The data will provide information about the formation, duration and movement of clouds, fog and dust plumes that can't easily be seen from space. "This is unexplored territory as far as atmospheric science goes," Smith says. "We've taken pictures of these clouds, but we don't know how high they are."

By coordinating with two spacecraft flying overhead, the team will be able to locate dust storms before they reach the landing site. "We'll do a complete study of dust storms on Mars for the first time," Smith says. ■

Back Story

1976

Viking 1 and 2 landers, sent to find life, landed on Mars and returned historic images — but no microbes.

1997

The Mars Pathfinder watched over the Sojourner Rover, which found clues suggesting past liquid water.

1998 to 2006

Mars Global Surveyor orbited the planet. It watched the weather, photographed the surface and mapped ideal landing sites.

2004 to present

The geologist-rovers Opportunity and Spirit continue to collect detailed data from the surface.

May 25, 2008

The Mars Phoenix Lander is set to land on Mars, looking for possibly life-friendly areas.

2009

The Mars Science Laboratory would assemble a miniature lab with the types of instruments now only at large labs on Earth.

ALL IMAGES FROM NASA; ILLUSTRATION BY CORBY WASTE/NASA-JPL

Humans

For longer versions of these and other Humans stories, visit **www.sciencenews.org**

Jaw breaker

Extinct hominid chewed softly, carried big teeth

By Bruce Bower

NUTCRACKER MAN, A MEMBER OF THE human evolutionary family best known for having massive jaws, peglike teeth and huge chewing muscles, was just an old softy. Although most researchers have assumed that this extinct relative evolved to eat nuts, seeds and other hard or fibrous foods, it actually favored tender vittles such as nutrient-rich fruits, a new study finds.

Nutcracker Man, or *Paranthropus boisei*, lived from 2.3 million to 1.2 million years ago in East Africa, the final species in a side-branch of human evolution.

No other member of the human family evolved choppers that measured up to those of *P. boisei*. But an analysis of microscopic marks on fossil teeth shows that this species concentrated on eating soft foods, despite its outsized chewing apparatus, report anthropologist Peter Ungar of the University of Arkansas in Fayetteville and his colleagues online April 30 in *PLoS ONE*.

"We need to reevaluate what we once thought about *P. boisei*," Ungar says. "A specialized anatomy can allow a species to avoid the very foods to which it is adapted when other, more preferred resources are available."

In other words, *P. boisei* may have evolved its unusual traits as a safety valve so that it could efficiently eat items such as nuts and seeds during tough times. When tastier choices such as fruits became available, they were fair game.

Modern gorillas eat in much the same way, Ungar notes. If given a choice, gorillas typically choose to munch fruit over leaves. Yet these animals display large, sharp teeth designed for ripping leaves apart.

Patterns of microscopic wear on *P. boisei* molars showed virtually no evidence of deep pits or parallel incisions, dental hallmarks of the recent consumption of hard and tough foods. "It looks more like they were eating Jell-O," Ungar says.

"This is as good and rigorous a study of *P. boisei* as we are likely to get," remarks anthropologist Bernard Wood of George Washington University in Washington, D.C. "It seems that these creatures could eat almost anything except flesh.... In that respect it confounds the hypothesis that they became extinct because they were up a dietary 'blind alley.'"

The Nutcracker Man had huge chompers (shown here), but new research suggests this extinct human relative munched soft foods.

Mental fluidity

Training improves scores on problem-solving tests

By Bruce Bower

MANY SCIENTISTS HAVE LONG REGARDED fluid intelligence — general reasoning skills and problem-solving proficiency — as a genetically ingrained, relatively stable trait that varies from person to person. But a relatively brief memory-training program can boost such mental skills, a new study finds.

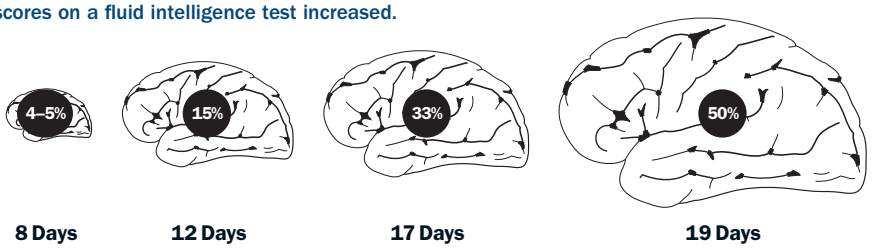
"Our finding that cognitive training can improve fluid intelligence in healthy young adults is a landmark result because this form of intelligence has been claimed to be largely immutable," says psychologist and study director Susanne Jaeggi of the University of Michigan in Ann Arbor.

The researchers tested fluid intelligence in 70 volunteers ages 22 to 29. Reporting online April 28 in *Proceedings of the National Academy of Sciences*, Jaeggi's team found that the more 25-minute memory training sessions completed daily, the higher participants scored on fluid intelligence tests, which use abstract and analogical problems unlike those on standard IQ tests. Participants who started out with either low or high fluid intelligence scores profited similarly from frequent, daily training.

Sociologist Linda Gottfredson of the University of Delaware in Newark says the new results are "intriguing, but it's premature to call them landmark or useful in education."

Jaeggi's group used abbreviated, possibly incomplete fluid intelligence tests and can't say whether reported training gains translate into any real-world advantages, Gottfredson cautions.

The more times people performed a daily 25-minute memory training exercise, the more their scores on a fluid intelligence test increased.



DONALD JOHANSON/ARIZONA STATE UNIV.

Body & Brain

For longer versions of these and other Body & Brain stories, visit **www.sciencenews.org**

Blind might one day see, suggest new studies in humans and mice

Genetic tricks offer a light at the end of the tunnel

By Tina Hesman Saey

SEEING THE LIGHT MIGHT NOW GET easier for people with a rare, genetic form of blindness. And studies on blind mice offer hope that people who have lost all the light processing cells in their eyes might not have to stay in the dark.

Gene therapy restored sight in three people with an inherited form of blindness called Leber's congenital amaurosis, researchers reported online April 27 in the *New England Journal of Medicine*.

The blinding disease results from mutations in the gene *RPE65*, which encodes a protein that helps rod cells in the eye recycle light-gathering pigments. Cone cells can take over for a while but also start to break down, usually resulting in blindness before age 40. About 2,000 to 3,000 people in the United States have the disease.

Researchers at the University of Pennsylvania and their colleagues injected the right eyes of three people who have the degenerative eye disease with an engineered virus containing a healthy copy of *RPE65*. All three people had improved vision a few weeks later in their right eyes. Two of the people were only able to distinguish hand movements before surgery. After treatment, the patients could read up to three lines on an eye chart.

Eye charts are subjective measures of sight, says Katherine High, director of the Center for Cellular and Molecular Therapeutics at Children's Hospital of Philadelphia, which sponsored the study. But the patients also improved on objective tests. When light was shone in patients' treated eyes, their pupils contracted, indicating that their retinas detected light.

"There's no teaching of that," High says. "It's just a reflex."

None of the patients regained 20/20 vision, says Jean Bennett, a molecular geneticist at the University of Pennsylvania who led the team. But all of them report better vision in dim light and increased ability to navigate.

"The improvement that we might think is trivial makes a big difference for them in terms of the quality of their lives," Bennett says.

Using a different method, another team restored vision in mice whose retinas had lost all the light-detecting rod and cone cells — without which mice and other animals, including humans, can't see. The results were published online April 27 in *Nature Neuroscience*.

Once these photoreceptor cells die, as happens in diseases such as retinitis pigmentosa or macular degeneration, there are few options for restoring them. Some researchers have tried stimulating retinas with electricity.

In 2006, scientists at Wayne State University in Detroit reported that they had inserted a gene for a light-gathering protein from a green algae, *Chlamydomonas reinhardtii*, into the retinas of mice with a disease similar to retinitis pigmentosa. The protein enabled the mice's damaged eyes to send messages to the brain when stimulated by light, but whether the algal protein or electrical stimulation of the entire retina could actually restore vision was unclear.

> **"The improvement that we might think is trivial makes a big difference in terms of the quality of their lives."**
> JEAN BENNETT

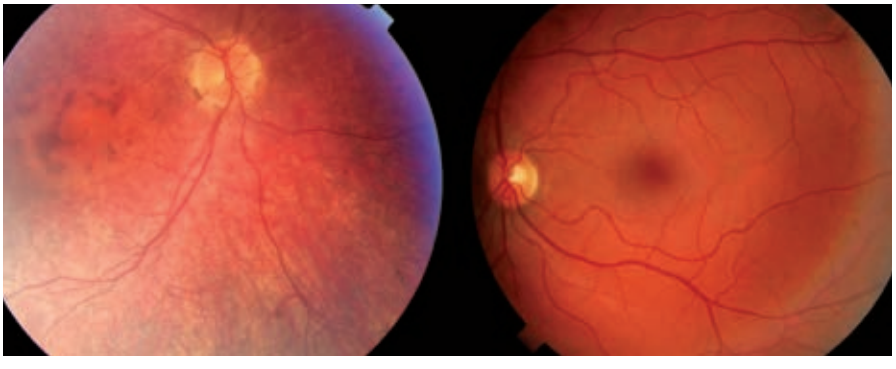
Now, Botond Roska, a neuroscientist at the Friedrich Miescher Institute for Biomedical Research in Basel, Switzerland, and his colleagues have inserted the light-gathering algal protein (ChR2) into certain cells in the retina's second layer. The secondary cells are called ON bipolar cells because they respond to brightening light, as when lights are turned on. Counterpart cells called OFF bipolar cells react to dimming light.

ON and OFF cells normally pass signals from rods and cones to the brain's visual center, so directly stimulating the cells should restore vision. Roska and his team showed that's just what happens.

The team used electrical current to infuse a piece of DNA carrying the gene *ChR2* into ON bipolar cells. The gene is controlled by a piece of DNA that allows it to turn on only in those cells. The technique produces protein only temporarily, so a more permanent method is needed to treat humans.

Blind mice engineered to make the

At left is the retina of a patient with the inherited disease Leber's congenital amaurosis, pallid compared to a normal retina (right). Injection of a new, healthy gene improved patients' vision.



J. BENNETT

4.5 million Estimated number of Americans who suffer from Alzheimer's disease

protein ChR2 in their ON cells scurry for cover when exposed to bright light just as normal mice do. Blind mice without the treatment don't respond to the light.

And the protein is "not just acting as a light sensor, it is activating visual systems in the brain," Roska says. A second test indicated that the vision-restored mice could make out lines on a rotating drum about half as well as mice with normal sight.

Algal proteins have a long a way to go before they make it into human eyes, experts agree. Researchers must first design viruses or other delivery mechanisms that can steer the light-gathering molecule only to ON cells. Still, the technique will not restore normal sight, Roska warns — just perhaps the ability to see objects (but not colors).

The algal protein is less sensitive to light and doesn't respond as well to changing light as rods and cones, so people would also need to wear devices that can even out lighting, Roska says. But "any improvement for patients is dramatic." ■

DNA change no good for diabetics

Increased protein production stimulates blood vessel growth and may lead to blindness and kidney failure

By Tina Hesman Saey

A TWEAK TO A DIABETIC'S DNA COULD TIP the balance toward blindness and kidney failure, a new study shows.

Natural variation in just a single base pair — letters of the genetic alphabet — raises levels of erythropoietin, one of the proteins that stimulate red blood cell production and blood vessel growth. Bumping up erythropoietin about doubles the risk that diabetics will develop diabetic retinopathy and end-stage kidney disease, a study published in the May 13 *Proceedings of the National Academy of Sciences* shows.

Controlling erythropoietin levels or blocking its activity could help diabetics stave off complications or halt the progression of diseases already attacking eyes and kidneys. At the same time, the protein is often prescribed to dialysis patients to pump up red blood cell counts, but the new research suggests doing so with caution, to avoid harming the eyes and kidneys.

Kang Zhang, an ophthalmologist and geneticist at the University of Utah School of Medicine in Salt Lake City, and his colleagues set out to solve a mystery that doctors who treat diabetics know well.

"We all see patients with their blood sugar completely under control, but they have complications right and left," Zhang says. "Then there are other people whose blood sugar is all out of whack, and yet, they never get into trouble."

Diabetic retinopathy results when too many blood vessels invade the retina, leading to tears in eye tissue or, most severely, detachment of the retina. The eye disease is the leading cause of new cases of blindness in working adults in the United States and is responsible for about 10 percent of blindness overall.

Zhang and his team chose 10 genes involved in blood vessel growth and looked for natural variations in the DNA sequence of the genes linked to greater risk of developing diabetes complications. The researchers found a change at a particular spot in a stretch of DNA that controls whether the erythropoietin gene is switched on or off. The variation increased the amount of erythropoietin in the eyes of non-diabetics with the genetic signature, the team found. Diabetics with the variation also had a higher risk of developing eye and kidney complications.

Still, other eye experts say controlling blood sugar could make a bigger difference in avoiding complications from diabetes than trying to block the protein.

NEWS BRIEFS

Treat 'em

Many physicians don't treat high blood pressure in very elderly people who are in otherwise good health, worrying that medication hurts more than helps. But Nigel Beckett, a geriatrician at Imperial College London, shows this perception may be wrong. He and his colleagues recruited 3,845 people from several countries who were at least 80 years old and had high blood pressure. The team reported in the May 1 *New England Journal of Medicine* that, in fact, volunteers who received medication, rather than placebos, were 21 percent less likely to die during the study. —*Nathan Seppa*

Fat cells gain weight

Even when people lose weight, they don't lose fat cells. The cells just shrink. Kirsty Spalding of the Karolinska Institute in Stockholm and her colleagues figured out the birth dates of fat cells in adults. The team reported online May 4 in *Nature* that, in adults, as fat cells die, the same number is replenished. Obese people have about twice the number of fat cells as normal-weight adults, and fat cells are bigger in obese people. —*Tina Hesman Saey*

Targeting Alzheimer's

Inhibiting the enzyme beta-secretase could neutralize an Alzheimer's suspect—the peptide amyloid-beta. A team in Germany has made a compound that anchors an inhibitor to a cell's membrane. When it was tested in mice, amyloid-beta production was halved, the researchers report in the April 25 *Science*. Though preliminary, the study shows the inhibitor can stay in the cell. Thus it's more likely to slow amyloid-beta production, says coauthor Kai Simons of the Max Planck Institute of Molecular Cell Biology and Genetics in Dresden. —*Nathan Seppa*

Life

For longer versions of these and other Life stories, visit **www.sciencenews.org**

New species could fill big shoes once worn by island's dispersers

Experiments suggest 'rewilding' for plant survival

By Sid Perkins

MISSING LINKS IN ECOSYSTEMS DISrupted by extinctions could be restored by introducing species that perform the same function, new field tests suggest.

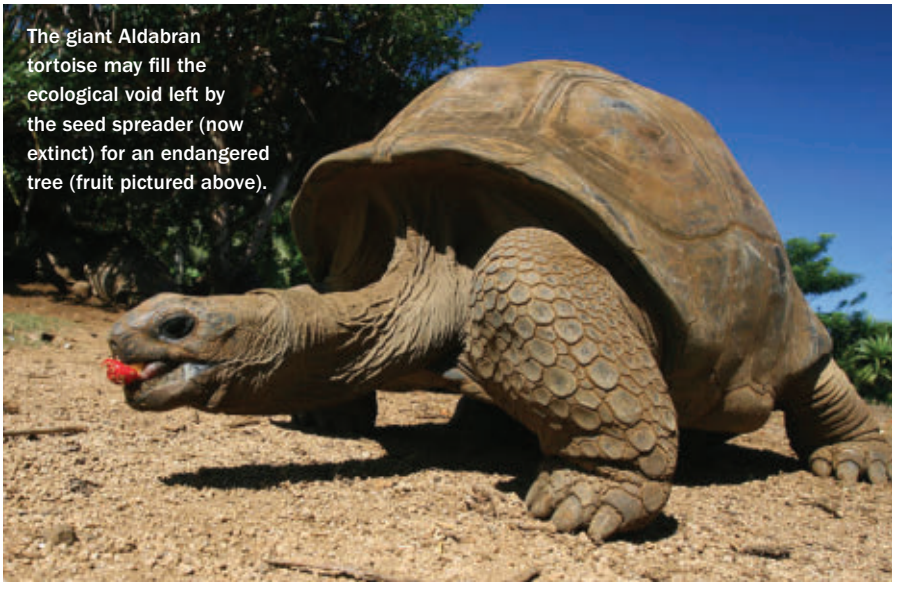
Mauritius, a remote island in the Indian Ocean, lost many of its creatures after Europeans colonized the island in the 17th century. Those die-offs now threaten many of the island's plants, especially the species that depend on frugivores to disperse their seeds.

Take, for example, *Syzygium mammillatum*, a critically endangered tree species whose fruit forms on the lowermost portion of its trunk. In a pristine forest area on the island, tropical ecologist Dennis M. Hansen of Stanford University and colleagues found no *S. mammillatum* seedlings or saplings more than two meters from adult trees. At such proximity, young trees would be more susceptible to foraging herbivores or diseases afflicting the adult tree.

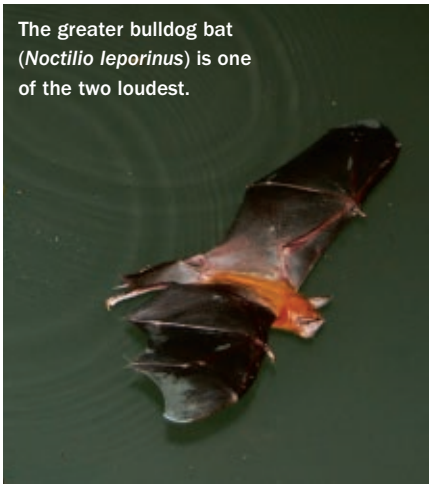
When the researchers fed *S. mammillatum* fruit to turkeys, none of the thin-hulled seeds survived passage through the bird's digestive tract. But about 15 percent of seeds from fruit fed to giant Aldabran tortoises passed through unscathed.

The researchers then scattered some gut-passed seeds and covered them with a layer of tortoise dung about 20 meters away from adult *S. mammillatum* trees.

The tests show that *S. mammillatum* seedlings from gut-passed seeds grew taller, had more leaves and suffered less damage than other seedlings, the researchers reported May 7 in *PLoS ONE*. These results indicate that the Aldabran tortoises, not native to the island, could replace the now-missing seed dispersers of *S. mammillatum*, and offer hope that other threatened plants can thrive if appropriate seed dispersers are introduced into Mauritius. But some scientists caution against the process, called "rewilding."



The giant Aldabran tortoise may fill the ecological void left by the seed spreader (now extinct) for an endangered tree (fruit pictured above).



The greater bulldog bat (*Noctilio leporinus*) is one of the two loudest.

Screaming bats make big noise

High-frequency sounds louder than fire alarms

By Susan Milius

BATS USING SOUND TO FIND THEIR WAY — and their food — in the dark boom louder than home fire alarms.

Fortunately all that noise stays at frequencies too high for human hearing, or bats would drive people batty.

Measurements from 11 species of tropical bats revealed extremely loud sounds, reports Annemarie Surlykke of the University of Southern Denmark in Odense. She and Elisabeth K.V. Kalko of the University of Ulm in Germany recorded and analyzed the yells bats emitted at the Smithsonian Tropical Research Institute's field station on Panama's Barro Colorado Island.

Species from four bat families made sounds that, at a distance of 10 centimeters, ranged from 122 to 134 decibels, the researchers reported April 30 in *PLoS ONE*. Two other species flying over open water made the loudest sounds yet recorded for any bat, averaging around 137 decibels. Home fire alarms reach about 108 decibels, says bat behavior specialist Brock Fenton of the University of Western Ontario in London, Canada.

D. HANSEN; CHRISTOPHER KAISER/SWISS FEDERAL INSTITUTE OF TECHNOLOGY; SIGNE BRINKLØV

Environment

6.8 metric tons The amount of greenhouse gases emitted per year in producing food for the average U.S. household

For food's ecological impact, meat means more than miles

'Buying local' has small effect on greenhouse gases

By Rachel Ehrenberg

BUYING LOCAL CERTAINLY REDUCES THE miles food goes before we eat. But consumers aiming to shrink their ecological footprints will get more bang for their environmental buck by eating less red meat and dairy, reports a new study. The analysis finds that delivering food to the consumer accounts for only 4 percent of food-associated greenhouse gas emissions, while production contributes a hefty 83 percent.

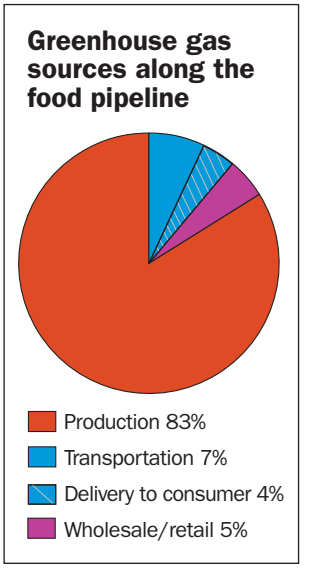
"There are many good reasons for going local," comments Rich Pirog, associate director of the Leopold Center for Sustainable Agriculture at Iowa State University in Ames. "But this study is important. Food miles alone are not a reliable indicator of environmental impact."

For the average U.S. consumer, getting the equivalent of one-seventh of a week's calories from chicken, fish or vegetables instead of red meat or dairy will do more to reduce greenhouse gas emissions than buying all local, all the time, the researchers say. Crunching the numbers revealed that delivery to the consumer accounts for only 1 percent of red meat–associated emissions. But the production path to red meat and dairy products is clouded with nitrous oxide and methane emissions, mainly from fertilizer use, manure management and animal digestion.

"Methane and nitrous oxide production are huge in agriculture," says first author Christopher Weber of Carnegie Mellon University in Pittsburgh. Other analyses have focused on carbon or energy use. "That misses a huge part of the picture," he says.

"I shop locally," notes Weber, who conducted the study with colleague H. Scott Matthews. "But there's been so much emphasis on food miles. We felt it was important to look at the whole life cycle."

Using data from the U.S. departments of Commerce, Agriculture and Transportation and from other sources, Weber and Matthews modeled the total greenhouse gas emissions generated in making and moving all sorts of foods, ranging from cereals to fish to cheese. The work appears in *Environmental Science & Technology* and paints a broad brush, cautions Weber. Because the model uses Commerce Department data, the food categories are defined by the department's food sectors. So while cheese and milk are considered separately, fruits and vegetables are put in the same category.



Apples and oranges aside, "more quantitative assessments like this are needed to help us understand the consequences of our choices," comments Greg Keoleian of the Center for Sustainable Systems at the University of Michigan in Ann Arbor.

Overwhelmed? Don't be. This new study just reemphasizes the sound advice people have been getting since elementary school, Pirog says.

"Eat a healthy balanced diet, with a minimum of processed food. Eat a moderate amount of dairy and meat. Eat more whole grains and veggies. Following that advice will probably reduce your carbon footprint," he says.

Warming trend bad for insects

Hotter weather threatens cold-blooded creatures too

By Rachel Ehrenberg

INSECTS, TURTLES AND OTHER CREAtures that use their environments to regulate their body temperatures may find themselves in hot water as global temperatures increase, a new study finds.

In the tropics, many of these animals are already living at the temperatures their bodies like best, with little wiggle room for dealing with a warming world.

Even though temperatures in the tropics are predicted to increase less than at higher latitudes, animals living in already warm places may be especially vulnerable, the study suggests. It isn't just the rate of warming that matters, but also the physiologies of insects and "cold-blooded" animals in those climates, says Curtis Deutsch of the University of California, Los Angeles.

Deutsch and collaborators integrated physiology data for 38 species of insects and some frogs, toads, lizards and turtles with climate models simulating global temperatures for the years 2070 to 2100. The results, in the May 6 *Proceedings of the National Academy of Sciences*, suggest that small temperature changes in the tropics may push some animals over the edge. At higher latitudes, the inverse may be true. Since northern temperatures are now less than ideal for many insects, they may thrive in warmer weather.

"There will be some winners and losers — it's hard to predict who those are," says Deutsch.

Atom & Cosmos

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Supermassive black hole says sayonara to its galaxy

Evidence supports simulations suggesting that gravitational recoil can trigger ejection

By Ron Cowen

KICKED OUT OF ITS HOME GALAXY BY a gravitational rocket, a supermassive black hole roams through intergalactic space, a solitary glutton seeking a fresh supply of gas and stars for its next meal.

It sounds like science fiction, but researchers have found the first observational hint that black holes millions to billions of times the mass of the sun really can be ejected from their galaxies.

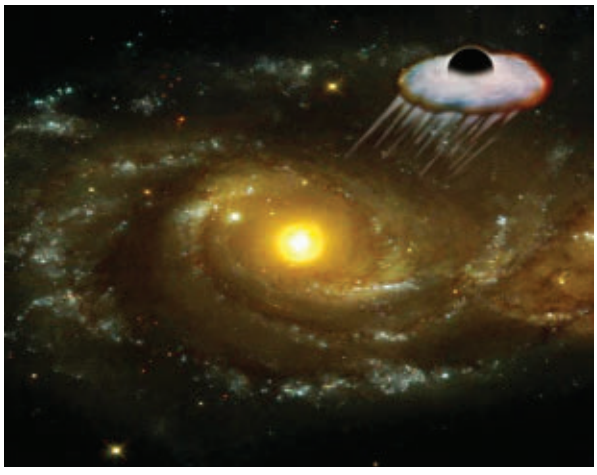
If confirmed, the finding would have far-reaching implications for understanding galaxy formation, as well as providing a profound confirmation of recent supercomputer simulations of Einstein's theory of general relativity.

The kick is believed to be generated when two giant black holes from different galaxies merge, unleashing an enormous burst of gravitational radiation. These proposed ripples in space-time, predicted by Einstein's theory, travel at the speed of light. Most of this gravitational radiation is emitted in one direction, pushing the merged black hole system in the opposite direction, like the kickback from a shotgun. If the kick is big enough, according to simulations, the merged supermassive black hole could exit its galaxy.

In their study, Stefanie Komossa and colleagues at the Max Planck Institute for Extraterrestrial Physics in Garching, Germany, examined light from a quasar, a brilliant beacon with the unwieldy name SDSS J092712.65+294344.0. Quasars, which lie at the center of galaxies, are fueled by black holes.

An analysis of the quasar spectrum reveals a pattern of light emission that matches that expected from a supermassive black hole shot out of the galaxy's center, the team reports in the May 10 *Astrophysical Journal Letters*.

Gas tightly bound to an ejected black hole would stay with the hole and rotate rapidly, producing a broad emission line showing up as a fat rather than narrow peak. Gas loosely bound to the hole just before the kick would stay behind. Since that gas rotates more slowly, it would produce a narrower emission line, as Komossa's team has detected.



The black hole in this illustration is rocketing out of its home galaxy, ejected by a burst of gravitational radiation. Astronomers say they have found the first suggestive evidence that such a scenario, predicted by theorists, actually happens.

The team calculates that the booted black hole is recoiling at 2,650 kilometers a second. "Its speed is so high that nothing will prevent it from ultimately leaving its host galaxy completely," Komossa says.

This scenario faces one potential problem — a puzzling third emission line, notes Cole Miller of the University of Maryland in College Park. The third line is also narrow but bluer in color than the other narrow line. Miller worries that the two colors indicate that Komossa's team is actually observing the superposition of two separate quasars that have similar but not identical distances from Earth. If so, the interpretation of a recoiling black hole would not be correct, Miller says. ■

Flooring the cosmic accelerator

New measure of dark energy suggests 'Big Rip' for universe

By Ron Cowen

BALTIMORE — LET 'ER RIP!

If cosmologist Will Percival of the University of Portsmouth in England is right, some 60 billion years from now every molecule and atom will be torn asunder by a runaway version of what astronomers call dark energy. An unidentified substance that pervades all space, dark energy causes the universe to expand at an accelerated rate.

Some studies hint that dark energy's strength is constant over time. But Percival and his colleagues, using the echo of sound waves from the early universe to measure the cosmic expansion, have found the first sign that dark energy could be growing stronger over time, as if someone had floored the cosmic gas pedal. That would lead to a universe ending in the Big Rip.

The notion isn't popular, as no known theory can account for runaway acceleration, notes theorist Robert Caldwell of Dartmouth College.

Percival presented the findings May 7 at a symposium at the Space Telescope Science Institute.

MPE, HST

Matter & Energy

Down with the transistor

New 'memristor' could radically transform computer chips

By Davide Castelvecchi

AFTER GOING UNCHALLENGED FOR decades, the transistor's supremacy could come to an end. Researchers have demonstrated a new type of electronic component that could replace transistors as the building blocks of computer chips and lead to faster, more powerful and less energy-thirsty computers.

Stanley Williams and his collaborators at HP Labs in Palo Alto, Calif., have created the memristor, a piece of an electric circuit with baggage: Its history determines its electrical resistance. Depending on the voltage recently applied to it, a memristor switches from acting as an insulator ("off") to acting as a conductor ("on") and back.

This on-off capability offers a way to build circuits that manipulate and store bits of information, representing a "1" in the "on" state and a "0" in the "off" state. "All of a sudden, you have a new tool in your toolbox," Williams says.

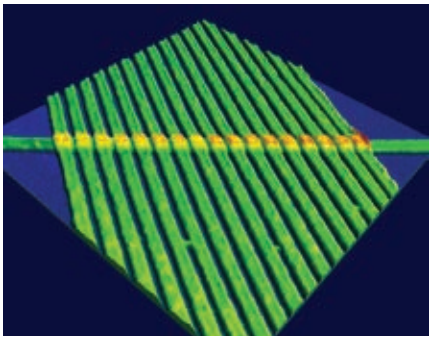
Memristors could be packed into chips up to 100 times more densely than transistors can. And information isn't lost when the device is shut down, similar to the non-hard drive memory in flash drives, cell phones and mp3 players. Williams says that his lab has already built prototypes of memristor-based computer memory that is tens of times denser than current flash drive memory or state-of-the-art RAM.

For decades, progress in electronics has relied on shrinking the features of computer chips, roughly doubling the number of transistors per chip every two years — a trend that has become known as Moore's law, after Intel co-founder Gordon Moore.

But Moore's law is expected to hit a hard wall in about 10 years. The memristor offers "an alternate way to continue progress," says Leon Chua, an electrical engineer at the University of California, Berkeley who first proposed the memristor concept in 1971.

Memristors exploit the very physics that makes it hard to shrink transistors. Transistors are built out of semiconducting materials, with properties that are finely tuned by adding small amounts of impurities called dopants. But voltages make dopant atoms move within a transistor and, at nanometer scales, this movement changes the semiconductor's properties and degrades performance.

Williams' team built the memristor by sandwiching a thin film of titanium dioxide between two platinum layers. Normally, titanium dioxide is an insulator. But applying a voltage between the platinum layers pushes the film's oxygen atoms toward one side. The moving atoms leave behind gaps in the titanium dioxide crystal structure. Such gaps create an imbalance in the distribution of electric charge, simulating the presence of positive ions. The gaps act like dopants and move in the opposite direction of the oxygen atoms.



Memristors are electronic components that, with a change in electrical resistance, can store data. This atomic force microscope image shows 17 memristors (appearing in yellow) sandwiched between parallel platinum wires (each about 50 nanometers wide) and a single crosswire.

Gap doping turns titanium dioxide into a good conductor, so the memristor switches to "on." But if the voltage is reversed, the oxygen atoms go back to their places, turning the memristor back to "off," the researchers describe in the May 1 *Nature*. ■

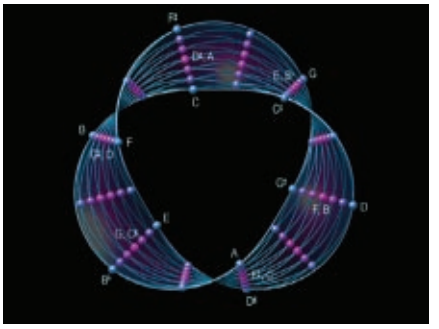
SCIENCE; J.J. YANG/HP LABS

The shape of Beethoven's Ninth

Math, music and multidimensional geometry intersect

By Davide Castelvecchi

FAMILIAR RELATIONSHIPS BETWEEN SETS of musical notes, such as transposition between chords, directly translate into geometrical structures such as this Möbius strip — where each dot represents a whole class of equivalent two-note chords — or into structures with many dimensions.



The relationships among musical chords translate into multidimensional geometry.

Composers understand these geometries without realizing it, says music theorist Dmitri Tymoczko of Princeton University. "Musicians like Chopin had a very direct, intuitive understanding of these spaces at a time when mathematicians still didn't know much about high-dimensional geometry," he says.

Wandering around these spaces, Tymoczko and his collaborators have found subtle relationships between progressions of chords that traditional musical theory would classify as unrelated — for example, between progressions in Beethoven's Ninth Symphony, the team reported in the April 18 *Science*. ■

Are identical triplets exactly alike? Indeed not. Life experiences have affected them as much as their genes have.

CARY WOLINSKY

Epic Genetics

Genes' chemical clothes may underlie the biology behind mental illness

BY TINA HESMAN SAEY

In research circles the debate is settled. Psychiatric illnesses are disorders rooted in biology.

As convincing as the evidence is, mysteries still fog our understanding of mental illnesses. Yes, the disorders stem from problems in the brain, but "on the other hand, for time and ages people have been looking at brains under the microscope, and they don't see much," says Schahram Akbarian, a psychiatrist and neuroscientist at the University of Massachusetts Medical School in Worcester. No lesions, malformations, scars or other outward signs distinguish a mentally ill brain from a healthy one.

In recent years, researchers have searched the genome for mutations linked to mental illness. The scans have been fruitful, perhaps too fruitful. Hundreds of genes have been implicated in predisposing a person to such disorders as addiction, schizophrenia, bipolar disorder, depression or anxiety. But no gene has been shown to be a master switch.

The debate has raged for decades over whether mental illnesses sprout from nature or nurture.

Scientists now suspect both. A new field linking genes and environment may chart the way for solving some of the mysteries shrouding mental illness.

Genes alone can only explain a few of the reasons people contract mental illnesses, become addicts or have developmental disorders, such as autism. Identical twins share a genetic makeup, so if genes controlled psychiatric disorders, whenever one twin developed a mental illness, the other would too. But that's not how it happens. Depending on the disorder, both twins develop it only about half the time. "We know the genetic risk of mental illness is about 50 percent, which leaves a whole other 50 percent unaccounted for," says Eric J. Nestler of the University of Texas Southwestern Medical Center at Dallas.

Some people say nurture, that is, "environment," is the root of psychiatric disorders, or at the very least accounts for the remainder of the risk. But no one has ever pinpointed exactly which experiences, infections, chemical exposures, types of stress or other environmental factors tip some brains into mental illness while others remain healthy despite the same insults, Akbarian says.

Scientists have also long sought explanations for why psychiatric disorders are so enduring, coming on slowly and then waxing and waning throughout life, or plunging addicts into craving, years after they've stopped taking drugs. Even the medications used to treat depression take weeks to grant relief.

The emerging field of epigenetics (which means "beyond genes") lies at this interface between genetics and environment and is revealing what marketers and Hollywood types have known for ages — that packaging is important.

Epigenetics is elucidating how environmental cues make their marks on genes. Such discoveries could help in understanding the mentally ill mind and lead to new treatments for psychiatric disorders and addiction.

Changing and not forgetting

EPIGENETIC MECHANISMS ALTER HOW cells use genes but don't change the DNA code in the genes themselves. The term "epigenetic" has been used for 60 years to describe the changes an organism experiences as it develops, but it has recently come to refer to the dozens of different modifications that DNA and its associated proteins undergo. All of the alterations essentially perform the same job: packaging genes properly.

Some of the modifications package genes so that they are shrink-wrapped tighter than a brand new CD, and just as hard to get into. Other epigenetic changes give cellular machinery easy access to genes. The ultimate effect is to finely tune to what degree a gene is turned on or off. Often the fine tuning is long-lasting, setting the level of a gene's activity for the lifetime of the cell.

Such extra-genetic programming is essential for cells to establish and maintain their identities throughout life.

"We don't need dopamine receptors in muscle cells, and we don't need neurons that produce liver enzymes," says Arturas Petronis, director of the Krembil Family Epigenetics Lab at the University of Toronto in Canada.

But the instructions for making dopamine receptors, liver enzymes, hair follicles and every structure in the body are found in every cell. Somehow unneeded genes must be shut down, and the genes that are necessary to form a particular cell type must be turned on. And once a cell's fate is determined, the course must be maintained.

Genes "without the right regulation can't perform all these functions," Petronis says.

Enter epigenetics, the molecular equivalent of the permanent record.

Once cells are programmed to be a brain, liver or heart cell, "they remember how to be that cell for the rest of their lives," says J. David Sweatt of the University of Alabama at Birmingham.

When cells "forget" their epigenetic programming, cancer or other diseases may result. But sometimes holding on to a program can be just as harmful, especially if that programming spurs a craving for cocaine or leads to obsessive hand washing or endless depression.

Programming errors

SCIENTISTS ARE ONLY BEGINNING TO learn how psychiatric disorders are linked to the packaging of DNA and the genes it contains.

One of the best studied of the epigenetic packaging choices is DNA methylation. Cells chemically mark genes they want to turn off by tacking a methyl group (one carbon and three hydrogen atoms) to the DNA base cytosine. But not just any old cytosine (the C of the DNA alphabet) gets modified. The alteration happens primarily where the DNA sequence consists mostly of C's and G's (the DNA base guanine). Scientists call such sequences CpG islands.

Genes have control regions that work like light switches or thermostats to flip genes on or off or nudge the level of activity up or down. CpG islands are often found in or near these control regions.

When a methyl group is pasted onto a C, a sort of molecular police tape goes up, declaring a gene off-limits to proteins called transcription factors that turn genes on. Other proteins act as guards to make sure that no transcription factors sneak past the tape.

Petronis and colleagues examined DNA-methylation patterns in brain tissue from deceased people who had had schizophrenia or bipolar disorder and from deceased people who had been mentally healthy. The group surveyed more than 7,000 CpG islands and found that about one in every 200 was methylated differently in people with major psychosis — a collective term for schizophrenia and bipolar disorder — than in people free from those disorders. That means that many genes are regulated differently in people with schizophrenia and bipolar disorder.

Some of the alterations affect activity of genes that are involved in regulating the brain's chemical communication

Many genes are regulated differently in people with schizophrenia and bipolar disorder than in people without those disorders.

system, its development or its response to stress. Some of the modifications even make tiny cellular powerhouses, called mitochondria, work differently.

Sperm from men with major psychosis also had altered DNA methylation compared with sperm from healthy men, the group reported in the March issue of the *American Journal of Human Genetics*. The result could mean that epigenetic packaging systems are faulty in people with schizophrenia and bipolar disorder.

"The good news is we have epigenetic changes," Akbarian says. "The bad news is that they are not so dramatic to give the telltale sign of disease."

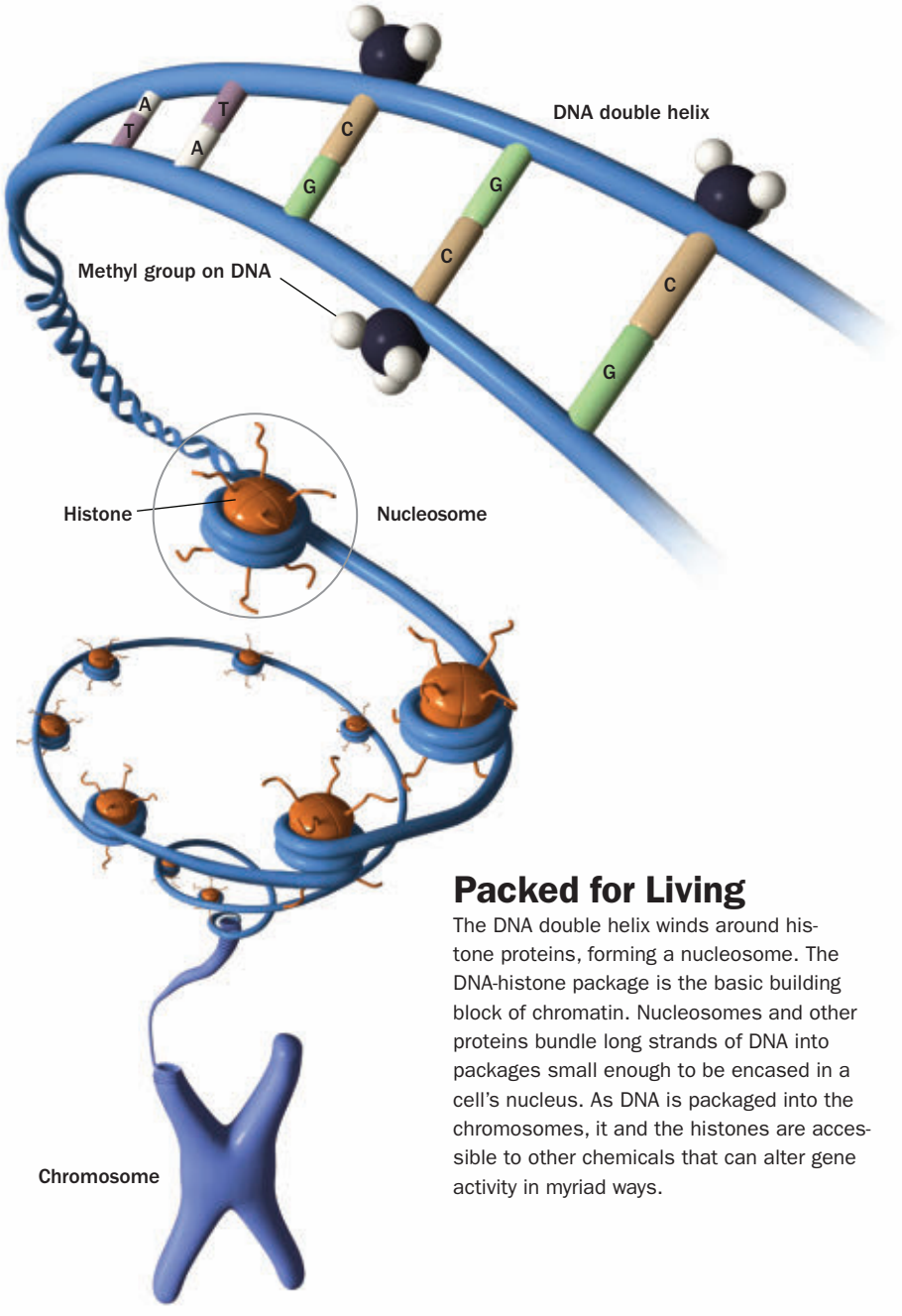
Several subtle epigenetic changes may add up to psychiatric disease, especially when paired with DNA mutations that make brains vulnerable to stress, he says.

Of mice and people

DNA METHYLATION IS ONLY ONE OF DOZens of various epigenetic packaging materials. Epigenetics is all about "–ylation," that is, the addition of one kind of chemical group or another to various proteins, fats, DNA and other molecules. Adding an acetyl group to a protein, for instance, is called acetylation. Tacking on phosphorus is, yes, phosphorylation, and so on.

DNA and its associated proteins are known collectively as chromatin. The most intimate of those proteins — called histones — are popular targets for modification. To fit nearly six feet of DNA inside a microscopic nucleus, a cell has to pack more efficiently than a tourist on a trip around the world. Histones are handy space-saving devices. Eight histone proteins get together and form a core around which DNA is wrapped. Other proteins help fold the DNA-histone complex into ever tighter structures until it can nestle comfortably in the cell nucleus.

These packing proteins are multitaskers. While stuffing DNA inside the nucleus, the proteins also help determine which genes will be turned off and on. The various epigenetic chemical modifications help direct the packing process, effectively deciding whether certain genes will be relegated to the bottom of the suitcase or stowed in accessible side compartments.



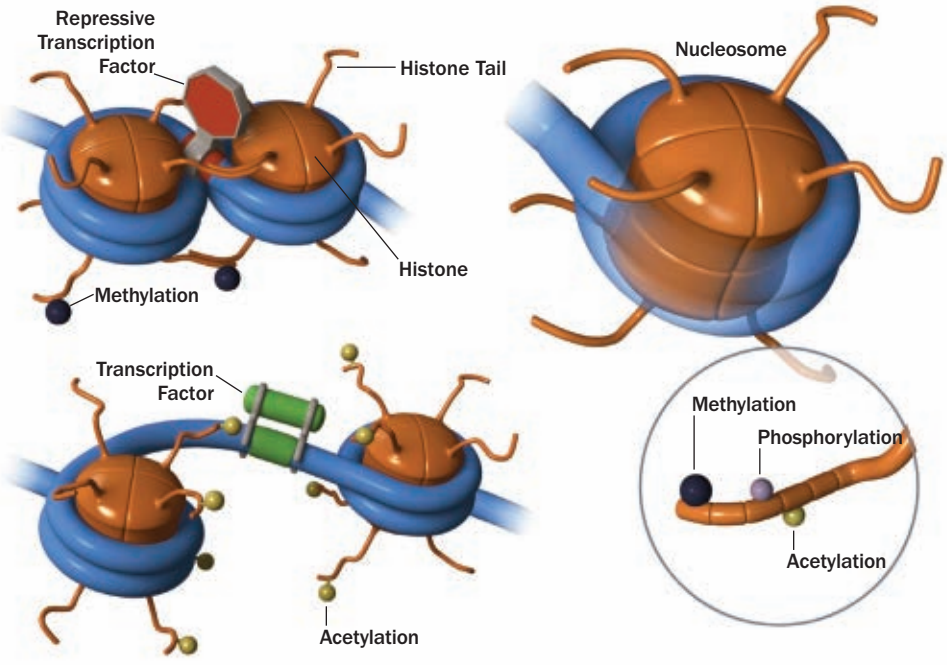
Packed for Living

The DNA double helix winds around histone proteins, forming a nucleosome. The DNA-histone package is the basic building block of chromatin. Nucleosomes and other proteins bundle long strands of DNA into packages small enough to be encased in a cell's nucleus. As DNA is packaged into the chromosomes, it and the histones are accessible to other chemicals that can alter gene activity in myriad ways.

CHARLES FLOYD

Snapping acetyl groups onto the tails of some of the histone proteins, for example, helps loosen the connection between DNA and histones, making genes more accessible to transcription factors. Phosphorylation and methylation of histones may either turn genes off or on, depending on where the chemicals are pinned to the histone tail.

Nestler and his colleagues have found that dramatic changes in chromatin packaging around a gene are linked to depression and addiction. Activity levels of a gene called *BDNF* (for brain-derived neurotrophic factor) in mice that are bullied day after day fall to about one-third the level found in non-stressed mice. The chronic bullying causes mice to avoid social contact with other animals, a symptom of depression. The "chronic defeat stress" experienced by the mice might also be a model for post-traumatic stress disorder, anxiety disorders and social phobias.



Open and Close

Chromatin, a complex of histones, DNA and other proteins, can be tightly packed (top left) so that it is closed and genes are shut off. Chromatin can also be loosely bundled (bottom left)—in this open state, the DNA is left accessible to transcription factors that can turn genes on. The tightness of the packing is controlled by chemical modifications to DNA and to the tails of the histone proteins. Many different chemicals can be added to the histone tails, and the combinations of those additions plus the action of other proteins let out or reel in slack in the bundling of chromatin, creating various stages of openness. This variation helps precisely tune gene activity.

And just as people don't just snap out of depression, mice don't easily get over bullying once they are allowed to lead a peaceful life. Their defeated demeanors persist for weeks after the bullying stops, as does the reduced activity of *BDNF* in their brains.

Antidepressants, such as imipramine and Prozac, reverse the effects of bullying on both social interactions and gene activity, but only when the mice keep taking the drug. A single dose of antidepressants doesn't help, Nestler says.

That trend is similar to the way antidepressants work in people. The drugs typically take several weeks to change how people feel and usually must be taken long-term to maintain beneficial effects.

Nestler and his colleagues looked closely at what happens to chromatin around the switches that control *BDNF* levels. The researchers found stressed mice had much higher levels of histone methylation than non-stressed mice had. In this case, methylation helps to close off chromatin and adjusts the thermostat to turn down *BDNF* activity.

Imipramine restores gene activity in the stressed mice, but it doesn't remove the repressive methylation from the histones. Instead, it doubles acetylation of one of the histones. Acetylation helps loosen chromatin, allowing cellular machinery better access to the genes. The antidepressant didn't increase acetylation in unstressed mice, indicating that the modification only happens to genes that are already tattooed with methylation. The antidepressant may increase acetylation by inhibiting enzymes, called histone deacetylases, which would otherwise remove acetyl groups from histones.

In fact, the researchers found that bullied mice on imipramine made less of an enzyme called histone deacetylase 5 (HDAC5), but mice in the no-stress group had normal levels of HDAC5 even after taking the antidepressant. The finding is notable because antidepressants such as imipramine are generally thought to have no effect on healthy people but to lift the spirits of people with depression, the researchers said in a 2006 *Nature Neuroscience* article describing the study.

Sodium butyrate, a drug that inhibits the action of histone deacetylases, also works as an antidepressant in mice, Akbarian and his colleagues reported last year in *Biological Psychiatry*. The result suggests that chromatin-modifying drugs could be therapeutic for some psychiatric disorders either alone or in combination with other medications.

Addictive packaging

EPIGENETIC MODIFICATIONS MAY ALSO account for some of the long-lasting effects of drug abuse.

When a person takes the first hit of cocaine, the brain's reward system feels it right away. A region near the base of the brain called the ventral tegmental area releases a flood of the feel-good chemical dopamine to another brain structure known as the nucleus accumbens. Drugs of abuse cause the nucleus accumbens to get a shot of dopamine or similar reward chemicals.

The dopamine signal spurs production of a transcription factor known as CREB. CREB's job is to turn on other genes, including one involved in stopping the flood of dopamine coming from the ventral tegmental area.

That stifling of the reward system breeds tolerance to drugs of abuse because the more CREB produced, the higher the dose of cocaine needed to overcome its dampening effects.

But the CREB gene switches off after only a few days without drugs. It can't account for drug addiction's staying power. Another gene, known as *delta-FosB,* also switches on when a wave of dopamine washes over the nucleus accumbens. Unlike short-lived CREB, the delta-FosB protein is a molecular Energizer Bunny. It persists for weeks after a dose of drugs.

Delta-FosB teams up with other transcription factors and recruits enzymes that acetylate histones and remodel control regions of some genes, such as *Cdk5*. The CDK5 protein then alters another

CHARLES FLOYD (BOTH)

protein that interacts with histone deacetylase enzymes, creating yet more chromatin renovations.

Such findings suggest that medicines that interrupt or reverse epigenetic changes caused by drugs of abuse could one day prevent or cure addiction. The findings also shed light on the way the brain gets high on life. Activity of the gene for delta-FosB is "also induced by high doses or consumption of natural rewards," such as exercise, sugar, high fat diets and sexual activity, Nestler said at a symposium on epigenetics and behavior held in March in Houston.

The way genes are packaged also influences learning and memory. Defects in DNA methylation are at the heart of Rett syndrome, an inherited form of autism that affects mostly girls. Other epigenetic changes have been linked to autism and to some types of mental retardation.

Long-lasting effects of epigenetic packaging may seem to consign some people to a lifetime of mental illness, but scientists studying the disorders take heart that the problems can be influenced by packaging. That means that even people who have battled depression or schizophrenia for years may one day be able to take a medication that would repackage their genes in a healthier manner.

People who are susceptible to psychiatric disorders or addiction might be able to effectively inoculate themselves against the disorders by taking a tonic to prevent their genes from getting wrapped up incorrectly. Such draughts are likely years or even decades away from showing up in the pharmacy, but scientists finally may be within yanking distance of the cloak of mystery covering mental illness. ■

Explore more

■ Tsankova, Nadia *et al*. "Epigenetic regulation in psychiatric disorders," *Nature Reviews Neuroscience*, May 2007.

You *can* hit 'undo'

Once a chisel hits marble, there's no second chance for a sculptor. Many researchers thought that once a methyl group was attached to DNA, the modification was also set in stone. Carbon–to–carbon bonds between the methyl group (one carbon and three hydrogens) and the DNA base are too strong to sever, the reasoning goes. Only five years ago, Michael Meaney, a behavioral geneticist at McGill University in Montreal, Canada, submitted a manuscript to a scientific journal detailing experiments showing that some genes can be demethylated—the methyl group can be plucked off the DNA base cytosine to which it is attached. The editor of the journal rejected the paper, saying that demethylation "just doesn't happen," Meaney says.

But recent evidence from Meaney's lab and others shows that DNA methylation is less like sculpting in marble and more like working with clay.

It's true that DNA methylation is the most enduring of epigenetic modifications, says Frances Champagne, a neuroscientist at Columbia University.

"It can be very stable, but it is just a chemical bond," Champagne says. And chemical bonds are made to be broken.

J. David Sweatt's group at the University of Alabama at Birmingham has been investigating methylation of the gene for BDNF. The researchers found that demethylation happens rapidly under certain conditions, such as when people experience stress.

"It seems solid in my mind that experience can trigger genes' demethylation," Sweatt told colleagues gathered in Houston in March for a symposium on epigenetics and behavior.

But even scientists who agree that demethylation is real don't know exactly how it happens.

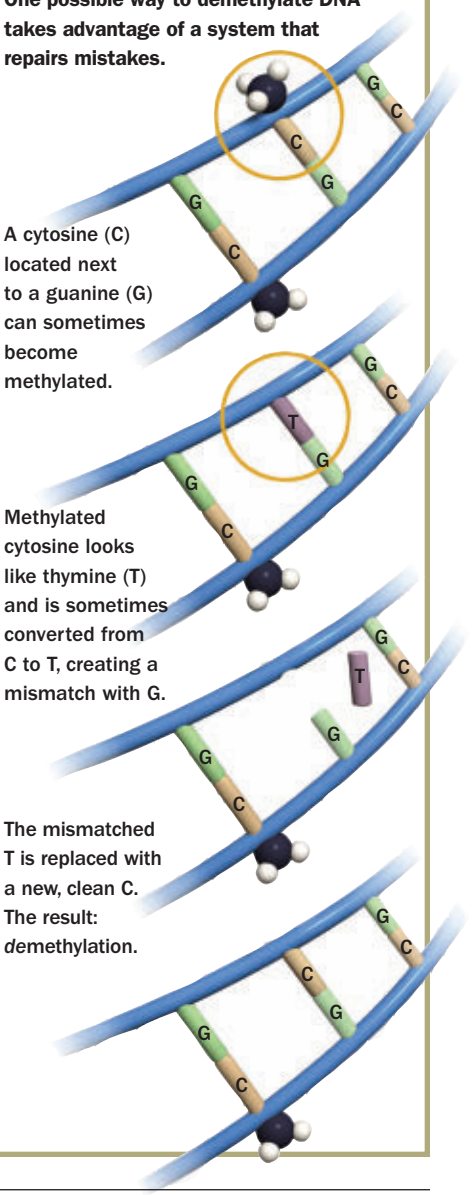
A group of European scientists presented evidence in the March 6 *Nature* that demethylation is carried out by a cellular system that tracks down and repairs mutations.

Cytosines with methyl groups stuck to them look very much like the DNA base thymine, and sometimes methylated C's get converted to T's. That creates a mismatch with the G on the opposite DNA strand. Cellular machinery scans the DNA for such mismatches, snips out the offending T and replaces it with a new C—one without a methyl group attached.

But the excision and repair system is probably only one way to pick methyl groups off DNA, Meaney says. He and others think the same enzymes that tag DNA with methyl groups also remove the modifications.

"The enzyme may work in both directions," Meaney said at the March meeting, "and this is not odd for an enzyme to be able to work in that way."

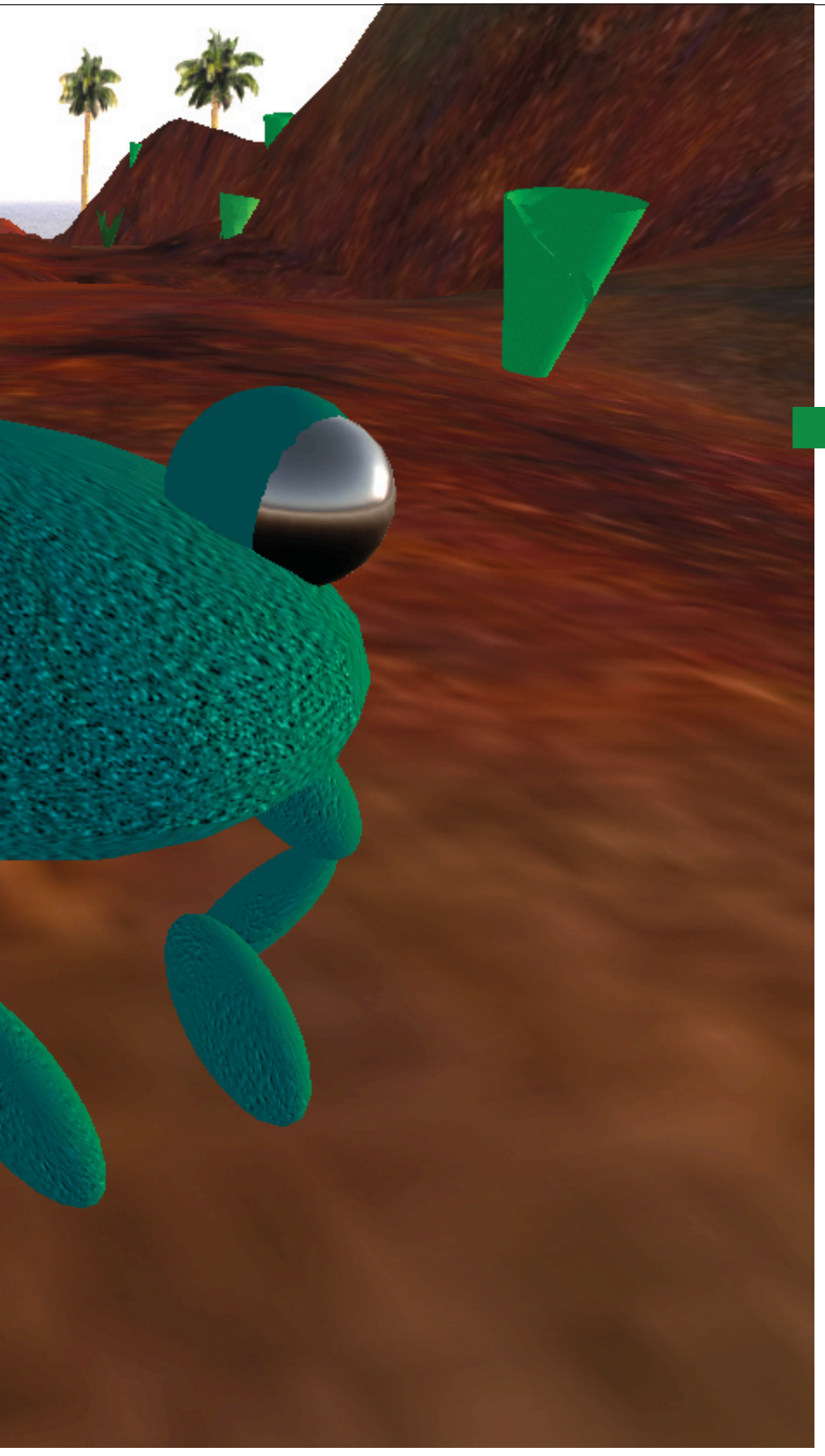
—Tina Hesman Saey



In the online virtual world known as Second Life, scientists conduct real research projects. Neurobiologist Corey Hart, for example, studies hopping movements in Simfrog, one of a series of "living" creatures that survive, evolve and interact in a virtual ecosystem.

C. HART

Scientists Get A 2nd Life



Online world opens up new ways to do and learn about science

by Terra Questi

To track down neuroscientist Corey Hart, you could stop by his laboratory, located on the second floor of Drexel University's medical building in Philadelphia. Or, you could visit the lab of Luciftias Neurocam, located in the virtual world of Second Life.

Luciftias is Hart's digital alter ego, or avatar. Like his real-life counterpart, Luciftias tracks the twitches of frogs' muscles to find clues to the spinal cord's ability to control movement.

Robert Amme, a physicist at the University of Denver, has a laboratory in Second Life, too. There his avatar double, Dr. Bob Vandeverre, is building a virtual nuclear reactor to help train the next generation of environmental engineers on how to deal with nuclear waste.

Hart and Amme are pioneers among a growing number of scientists and educators now using the online world of Second Life to pursue real-life science.

Created in 2003 by Linden Lab of San Francisco, Second Life — or SL as it's known to its members or "residents" — is a 3-D world that allows users to buy "property" (actually time on one of Linden's powerful computer simulators), create objects and buildings, and interact with other users. Unlike a game, with rules and goals, SL offers an open-ended platform where users can shape their own environ-

ments. In this world, avatars do many of the same things real people do: work, shop, go to school, socialize with friends and attend rock concerts.

SL is largely known for its recreational and business activities. But it's increasingly becoming a world where scientists and educators go to get down to real science. After starting out as a handful of individual efforts, SL's SciLands has grown into a mini-continent with 45 simulated islands or "sims." More than 300 universities and museums now maintain a presence in SL, as do an alphabet-soup list of organizations such as NASA, NOAA, ACS and the CDC.

"Early on, when SL really got going, it looked like it was going to be a huge playground," says Amme. "I thought personally, who needs a second life unless you don't have a first one?"

Although SL retains a large recreational component, with fantasy, racy nightclubs and sex, the science islands have distinguished themselves as places to connect with the "outside" world. Scientist-avatars guide students through formal university educational programs — such as the University of Denver's master's degree in environmental engineering — or create exhibits designed to demonstrate scientific principles. Navigational tools let users zoom in and around objects, making SL a convenient place to investigate phenomena that would otherwise be hard to visualize or understand. Avatars can, for example, initiate chemical reactions with a touch of their hand, watch a tsunami form or stroll through the internal structures of a cell.

"Second Life *is* real life. It's just a different medium for communication."
Joanna Scott,
Nature Publishing Group

But the 3-D visualization is only part of the draw. With 13.4 million registered users from more than 100 countries (Americans make up less than a third of the members), SL provides a rare opportunity for scientists to interact with the public, and vice versa, says Joanna Scott, who oversees the Nature Publishing Group's three islands: Second Nature, Second Nature 2 and Second Nature 3.

Last fall, Scott initiated a lecture series where real scientists enter SL and talk on a wide range of topics. As the scientist-avatar speaks into a microphone, the sound is streamed through SL's audio system. Anyone from SL can attend and participate in the discussion following the talk. During one recent lecture, people from all over the world came to hear a scientist from Royal Holloway, University of London, talk about climate change. Scott is now seeking ways to stream images, via webcam, from real-life lectures into SL so that people can communicate across worlds and participate in the same events.

Such "mixed world" events, gatherings that take place simultaneously in SL and real life, remove many of the long-standing barriers in science communication. "Chances are, the scientist would never have traveled all over the world to talk about his work, and nobody from South Carolina would have traveled such a great distance to listen to him," Scott says.

Although SL is not the first online virtual world, experts say better Internet connections, more realistic graphics and a boom in the video industry are driving forces behind the new interest in using such environments, especially in the classroom.

"Students are no longer prepared to learn using traditional techniques," says Tracy Kennedy, a University of Toronto lecturer who studies educational uses of online virtual worlds.

Through iPods and mp3 players, Facebook, cell phones and texting, young people become familiar with current technologies and often view them as an extension of themselves, Kennedy says. As a result, they're drawn to learning techniques that employ novel devices. "Most of this younger generation has grown up entirely with the Internet. How can we not incorporate technology into our curriculum?" she says.

Entering SL is easy: You simply download some free software and choose an avatar and name. Mine is Terra Questi. Recently, after a brief stop at Orientation Island — where I learned to chat, fly and manipulate virtual objects — I set out on a tour to get a firsthand view of Second Life's science.

A virtual world evolving

MY FIRST STOP: SECOND NATURE 3, AN ISLAND where Drexel neuroscientist Hart has created a virtual ecosystem with plants and animals that can evolve and live out lives of their own. "Cobblefish" and "jellypods" swim in the clear, blue waters surrounding the island. On land, bees whiz by to pollinate plants, which then produce seeds that grow. Hart created everything on the island using building tools called "prims." He is now putting together a new creature called Simfrog, a virtual clone of his slimy flesh-and-bones lab model.

Back in his bricks-and-mortar lab, Hart uses an electromyograph to track neural pathways involved in frogs' hopping. Here in his virtual lab, he plans to explore the early development of those patterns and figure out why the frog evolved the neural combination it did. By putting Simfrog under various evolutionary pressures — forcing it to forage for food and dodge predators — Hart wants to see if alternative motor pathways emerge from an incalculable number of possibilities.

"With motor control you have all these different muscles, so the question is, how do you choose the right combination of muscles to execute a movement?" Hart says. "Theoretically, there's almost an infinite number of ways you could execute any given movement."

Besides answering his own research questions, Hart sees the ecosystem as a way to illustrate lessons in evolutionary biology for non-scientists. He has done all the programming needed to allow other users to develop and release plants or animals onto the island. So occasionally a new critter or plant will appear.

"Sometimes they get out of hand, and I have to go in and play God and kill something off because it was poorly designed," he says, recounting the example of a prolific seed-producing plant that created havoc on the island. The plant spewed scads of ill-adapted seeds into the air. Because they were not programmed to take root and sprout, the seeds tumbled when they hit the ground,

steamrolling over other plants and creating a pileup in the island ravine. The island's computer responded by crashing.

Extra-credit chemistry

I TELEPORT TO DREXEL ISLAND, WHERE REAL-LIFE CHEMIST Jean-Claude Bradley sends his avatar, Horace Moody, to meet me. Moody, a spry plum-colored cat, is the first animal avatar, or "furry," I've encountered.

Despite his initial skepticism, last year Bradley helped establish his university's presence in SL. He now uses the program to augment his introductory course on organic chemistry. By clicking on an obelisk, students can view a series of molecular images and choose an image that corresponds with a question. The students compete in races to work through a series of 20 to 30 questions, with real prizes awarded for the winner.

Students may also use SL to interact with and create representations of chemical reactions. Last fall, one of Bradley's students created a life-size model of a camphor molecule for extra credit, now on display on one of the Second Nature islands.

Bradley is one of an estimated 5,000 educators worldwide using SL in their curricula. Some use it to bring in guest speakers from across the world or to encourage students to explore topics on their own. Others, like Amme, immerse their students in virtual worlds, with courses and programs held entirely in SL.

Bradley says that although only a fraction of his students — 5 to 10 percent — currently participate in SL, that number is likely to increase as students become more familiar with it.

"There's a misconception out there that all students are very tech-savvy, and that's simply not true," he says. "Second Life provides an additional way for students to explore class material, but it doesn't appeal to everyone."

A steep learning curve can also discourage students who are not highly motivated to use SL, he says. Statistics from Linden Lab show that only about one in 10 people who register in SL actually become regular users. I keep this statistic in mind as I jet off to my next destination.

Learning to fly

IN MANY WAYS, SECOND LIFE IS JUST LIKE REAL LIFE, AND THINGS don't always go smoothly. Despite hours of practice, I still have difficulty flying at high altitudes.

Ourania Fizgig, avatar for University of Arizona's Adrienne Gauthier, giggles (yes, avatars can emote) and hands me a flight feather so that I can fly as high as I want. Learning to navigate in SL takes time, Ourania says. "When I first went into Second Life, I spent 30 hours — one whole week — immersing myself and finding links to various places. I don't think I felt comfortable until I was in the world for maybe 80 hours."

For her online lab sessions at the university, she brings in real-life assistants to help student users navigate in SL. Still, many of them are struggling at the end of the semester to complete even the basic tasks.

Ourania leads me to an island she developed for the University of Arizona's Steward Observatory called LivingintheUniverse. Here, her students have created an interactive timeline of

Second Life Stats

Location
3,000-plus servers located at Linden Lab's data center in San Francisco and hubs in Austin, Texas.

Total Area
Mainland plus 905 islands, representing more than 494 square miles of land, growing daily.

Population
13.4 million registered users to date with 1.1 million users active during the past 60 days.

Users
People 25 to 34 years of age make up about 35 percent of users. About 59 percent of registered users are male and 41 percent female.

Cost of Land
A 16-acre island costs $1,675 up-front, with maintenance fees running $295 a month. A 50 percent discount is available for educators in academic institutions and non-profit organizations.

Students listen to microbiologist Joan Slonczewski talk on science and science fiction on the American Chemical Society's island (top). Horace Moody (chemist Jean-Claude Bradley) pauses in front of exploding pumpkins at a "mixed-world" poster session on the island (bottom).

T. QUESTI

Earth's history, from 4.6 billion years ago to the present. As we enter the timeline, Ourania interrupts the tour to show me how to run. Crossing through the ages, we zigzag between asteroids in the late heavy bombardment period, and sprint through a torrential downpour that simulates the conditions 4.2 billion years ago when the oceans started to form.

Further down the timeline, posters dot the landscape, illustrating various scientific events through the ages: the first living cell, the beginning of photosynthesis and the birth of science. By clicking a poster, users can collect information on each event.

Gauthier says she is looking for ways to make exhibits more active, especially as she plans ahead to celebrate the International Year of Astronomy in 2009. Recently named to the SL-wide, multi-institutional committee for this celebration, she is applying for grants to open a virtual astronomy center that could offer the latest news and imagery on astronomical objects.

"There are some incredible things you can do in SL, but it takes money to purchase the land and hire the kinds of experts and gurus that know how to make things work," she says.

The cost of buying and maintaining an island for the first year is in excess of $3,000. Though researchers say SL funding is scarce, some funds are available. The National Science Foundation, for example, has provided more than $6.5 million to date to explore and develop educational opportunities in SL and other virtual worlds. Amme's nuclear reactor is funded by a $200,000 grant from the U.S. Nuclear Regulatory Commission.

Samplings of Second Life Science

Science Friday
NPR's Ira Flatow delivers his radio show through his avatar, Ira Flatley, and takes on-air questions from SL attendees.

SciLands
A mini-continent with more than 20 science and technology related organizations.

A Walk on the Moon
See a space capsule and buggy similar to those used by the original earthly visitors. Climb the stairs and take a peek inside. Pick up note cards along the way that explain the science.

Genome Island
Help sort pea gametes in Mendel's garden, or see the structure of DNA.

NOAA
Located on a sim called Meteroa, it offers a sea-life submarine ride, two tsunami demos, an airplane ride in a hurricane and a melting glacier.

The International Space Flight Museum
Explore rockets, see models of the International Space Station and the Hubble Space Telescope, or teleport to the Apollo 11 lunar-landing site.

Terra Questi on the moon.

T. QUESTI

In-world conferencing

WHILE SOME SCIENTISTS SEEK WAYS TO RAISE FUNDS FOR THEIR SL projects in the real world, others are finding ways to make a living in-world. One is Troy McConaghy, who helps others develop exhibits and events in SL such as NanoLands, a relatively new site on Nanotechnology Island. After receiving his doctorate in aeronautics and astronautics from Purdue University, McConaghy entered SL. For the past three years, he has documented the evolution of SL science in his blog at www.troymcconaghy.com, where he lists all SL science sites and events.

"At first it was easy because there wasn't a whole lot to keep track of," he says. Now the list includes an ever-growing string of conferences and seminars. "I can see a day in the not-so-distant future when there is an event going on every day in science."

McConaghy, whose avatar Troy McLuhan attends several meetings a week in SL, says virtual conferencing is one of the fastest-growing SL activities, allowing people to attend meetings they couldn't ordinarily fit into their time or budget. This April, the International Virtual Association of Surgeons hosted the first fully in-world SL conference.

Virtual conferencing is especially advantageous in science, McConaghy adds, where research efforts can transcend several disciplines. "Molecular biologists and electrical engineers may be doing similar things in modeling and simulations, but they wouldn't ordinarily go to each others' conferences," he says.

And the public's interaction with virtual worlds is just beginning, he says. A presence in Second Life or some other virtual world may become as commonplace as having an e-mail address.

His words remind me of something Scott said when she talked about developing the lecture series for Nature. "Second Life *is* real life. It's just a different medium for communication."

Back in Second Life, I set out for one more place, a destination I will likely never travel to in real life — the moon. I reach the site of the Apollo 11 landing through a link set up by Elon University and grab a pair of space boots. As I explore the moon and the machinery left behind, the boots leave imprints of my tracks on the moon's surface. Finally, I prepare to leave, stashing my flight feather away in my inventory. I'll soon be returning to Second Life for a second look. ■

Terra Questi is the avatar identity of Susan Gaidos, a freelance science writer in Maine.

Explore more
■ secondlife.com/whatis/

Faith Seeking Understanding: Eight Extraordinary Men Unraveling Reason and Religion

Cross the Intellectual Bridge between Augustine to Ockham with an Award-winning Educator and Expert in Medieval Philosophy

Are philosophy and religion—reason and faith—fundamentally at odds? From today's strict division between questions of logic and questions of belief, one might think so. But for 1,000 years during a pivotal era of Western thought, reason and faith went hand-in-hand in the search for answers to the profound issues investigated by Christianity's most committed scholars:

- Can God's existence and attributes be established by reason alone?
- Are there Christian doctrines that are beyond the scope of logical demonstration?
- How can Christian belief be defended and shown to be internally consistent?

These questions posed by philosophers of the Middle Ages are emblematic of an extraordinarily rich period of intellectual ferment, when the best minds of the age participated in a common struggle with transcendent questions, using reasoning in the service of faith.

In **Reason and Faith: Philosophy in the Middle Ages**, you will examine the great Christian philosophers from Augustine to Ockham, and follow their efforts to illuminate the full scope of Christian doctrine using philosophical tools inherited, in large part, from the ancient Greeks.

Far from being "Dark" Ages, this was an era when faith was not blind and reason was not godless, when philosophers and theologians were the very same people, and no one saw anything surprising about that.

About Your Professor

Professor Thomas Williams is Associate Professor of Philosophy and Religious Studies at the University of South Florida. He received his B.A. from Vanderbilt University and his Ph.D. in Philosophy from the University of Notre Dame. He has been honored as the Alvin Plantinga Fellow in the Center for Philosophy of Religion at Notre Dame.

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The Angel Gabriel

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Science in the City

First-ever festival explores the science in culture, arts and life

BY RACHEL EHRENBERG

The festival highlights connections between science and art. Scientific analyses suggest that the scene depicted on this Late Classical terra-cotta bowl — that of an artist painting a sculpture — was a common activity.

METROPOLITAN MUSEUM OF ART (BOTH)

Scientists play an important role as myth busters, yet they seem unable to shatter one common fiction: "People think scientists are crazy white guys with frizzy hair in lab coats who don't communicate with normal people," says planetary scientist Heidi Hammel.

Dispelling this notion — and the idea that science is the stuff only of cloistered laboratories, dank with formaldehyde — is a hoped-for outcome of the upcoming World Science Festival in New York City. The five-day festival, May 28 through June 1, will offer 40 different events at 15 venues. There, Hammel and other leaders from physics, cell biology, psychology and other fields will celebrate science with pioneers from the worlds of modern dance, architecture, poetry and music. The anticipated audience is families, artists, students and anyone wanting a taste of the science around them.

The program includes a screening of *The Bourne Identity* at the Museum of Modern Art followed by a discussion of the neuroscience behind the main character's mental turmoil. NBA athletes will join physiologists, physicists and nutritionists to demonstrate the science of sports. Mapping the challenges cities face will be tackled by trailblazers from the fields of engineering, public health, architecture and sustainable development.

The kick-off will be a closed-door, one-day "World Science Summit" on May 28. More than 100 scientists, policy-makers, educators, and business and cultural leaders will convene to discuss science's role in and impact on global affairs. Also, the three inaugural winners of the Kavli prizes in astrophysics, nanoscience and neuroscience will be announced via a simulcast from Oslo. Established by entrepreneur Fred Kavli, the prizes honor scientific

achievement and creativity with a scroll, a medal and $1 million.

The festival is the brainchild of superstring theorist Brian Greene of Columbia University and his wife, television producer Tracy Day, and will emphasize connections between science and other disciplines. It also aims to spotlight qualities shared by scientists and artists alike: creativity, curiosity, a sense of wonder — the stuff of being human.

"My experience has been that people love to learn about the hidden aspects of reality ... the fundamental questions and truths that transcend everyday life," Greene says. "People can be wowed by the depth and insight science can provide."

Five universities, as well as scientific and cultural institutions and government agencies, are partners in the endeavor. Swiss bank Credit Suisse is the principal sponsor.

A program titled "Illuminating Genius" will combine live performances, personal narratives and state-of-the art imaging technology to delve into questions about the creative process. Featuring performance artists Anna Deavere Smith and Bill T. Jones and scientists Vilayanur Ramachandran, David Eagleman and Nancy Andreasen, the program explores the idea of the innovative brain.

In the United States, "we do not have an adequate emphasis on the importance and excitement of science," says Andreasen, known for her pioneering work using brain-scanning techniques to explore the neural basis of mental illness.

Andreasen will discuss her recent work scanning the brains of highly creative people. Singled out for their innovative approaches to problem-solving, her subjects have included Fields medalists, Nobel laureates and MacArthur fellows.

"My theory is the creative brain of an artist and a scientist is not different — there's a capacity to make novel associations," she says. And her brain-imaging work suggests she's onto something. The creative brains "all light up in the same way," she says.

Greene hopes the festival will light new entryways to science. "Someone who wouldn't go to a science fair but would go to the Guggenheim might come for the art and leave with the science," he says.

Chemistry Nobel laureate Richard Ernst will speak about Tibetan paintings, such as this late 14th century piece, "Mandala of Jnanadakini," at one of many festival events highlighting the intersection of science and the arts.

Many of the festival events should have such appeal, such as one at the Metropolitan Museum of Art offering a series of speakers who will connect the worlds of art and science. Richard Ernst, a chemistry Nobel laureate who is also an art collector and an expert in Tibetan paintings, will deliver the keynote address. Other speakers include research scientists from the Met and from New York University who will discuss the techniques for revealing the ancient paints and gilding applied to classical Greek and Roman sculptures. Harvard University's Narayan Khandekar will delve into a technical analysis of three paintings attributed to Jackson Pollock.

"What might not be immediately evident to a visitor of a place like the Metropolitan Museum is that there's a relatively large scientific operation going on," says Marco Leona, the museum's head scientist. Trained as a chemist, Leona's dissertation focused on properties of liquid crystals and materials for lasers. But he always had an interest in art (likely fostered by studying in Italy, where "people pay attention to the humanities," he notes). The Met has 10 scientists on staff. "We're doing chemistry and research just like a lot of labs; it just happens that we work on art."

If people come away from the festival understanding not only that science lurks in museums of fine art, but also that science is everywhere, Greene will be pleased. "To have a general public that is intimidated or put off by science is hugely debilitating," he says.

Hammel, co-director of research at the Space Science Institute in Boulder, Colo., agrees. Throughout her career, she has drawn connections between science and regular life, encouraging youngsters to see science as "something that they can do."

Hammel will speak at a presentation at the New Victory Theater that will showcase the French circus troupe Compagnie 111. "The shapes of things, movement — it's all about gravity," she says. "Whether it's on people or on planets, it's the same basic laws." ■

Explore more

■ www.worldsciencefestival.com

Microcosm: *E. coli* and the New Science of Life

Carl Zimmer

When science writer Zimmer looks into a petri dish teeming with *E. coli*, he sees himself, humanity and all life. In *Microcosm*, Zimmer traces the lessons biologists have learned from the microbe, which calls our guts its home. He also uses it to discuss some of the most fundamental questions in biology: What is life? How does it persist? Why must it end?

"I look at life through a lens made of *E. coli*," Zimmer writes, and many biologists are doing the same. *E. coli* was the species scientists first used to decipher the genetic code, and later to understand how genes switch on and off. It has also been a model for studying how creatures sense and swim, cooperate, wage war and allocate resources.

The reader could tire of the metaphor of *E. coli* as looking glass, but Zimmer writes simply and with enthusiasm. He describes the experiments that moved the field forward, but at the same time gives context for the findings. He pounds his point home so he can pull the picture together in the last few chapters. The biography of a bacterium morphs into a discussion on the meaning of life.

E. coli ushered in molecular biology and then synthetic biology. If scientists can genetically engineer *E. coli*, why not any animal, Zimmer asks. Although this idea makes some people squirm, he argues that natural hybridization has already inserted foreign DNA into our cells. And mitochondria, after all, began as oxygen-breathing bacteria. The point: There is no essence that defines a species. Instead, there is "a complex cloud of genes, traits, environmental influences and cultural forces," Zimmer writes. *E. coli* continues to help us understand how these factors interact. **—Elizabeth Quill**

Pantheon Books, 2008, 243 p., $25.95.

Curiosity and Enlightenment: Collectors and Collections from the Sixteenth to the Nineteenth Century

Arthur MacGregor

Chock-full of unicorn horns (narwhal teeth), griffin claws (antelope antlers), leopard skins, petrified wood or other gems hand-picked from nature, "cabinets of curiosities" have developed a modern-day reputation as whimsical caboodles of miscellaneous oddities. This book will overturn that impression. A proper collection was "a model of universal nature, made private," as Francis Bacon, the 17th century philosopher and statesman, is quoted.

In providing a grand tour of Western European collections, MacGregor shows that "purposeful collecting" embodied nothing less than revolutionary thought on cosmology and nature. MacGregor, a curator at the Ashmolean Museum in England, pays special attention to the changes in organization, preservation and interpretations of insects, birds, shells, gems and other natural items between the Renaissance and the Enlightenment.

The collections often evolved into public museums, and their popularity led to creative innovations in preservation and presentation techniques. How, for example, should the life cycle of a tree be displayed, or the anatomical lessons of a corpse tastefully exposed?

By the mid-1700s museum collections of the animal world were being reorganized according to Linnaeus' rankings, and anatomical collections were incorporated into medical schools. With each illustration and description—a perfect glass flower, wax heart, scrutinized fossil or embryo placed according to its similarity to another kind of animal embryo—MacGregor tells a tale of how modern science began.

—Amy Maxmen

Yale Univ. Press, 2007, 386 p., $75.

Archimedes to Hawking: Laws of Science and the Great Minds Behind Them

Clifford Pickover

How the works of these and other great minds have changed humankind's understanding of the universe.

Oxford Univ. Press, 2008, 514 p., $27.95.

Winter Trees

Carole Gerber

In this picture book, a child uses sight and touch to identify seven common trees, even after they've lost their leaves.

Charlesbridge Publishing, 2008, 30 p., $15.95.

Guesstimation: Solving the World's Problems on the Back of a Cocktail Napkin

Lawrence Weinstein and John A. Adam

Learn to use simple arithmetic to approximate anything.

Princeton Univ. Press, 2008, 300 p., $19.95.

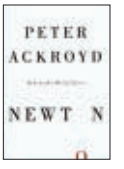
Manipulative Monkeys: The Capuchins of Lomas Barbudal

Susan Perry

Primatologists follow the social lives of these big-brained Costa Rican monkeys.

Harvard Univ. Press, 2008, 358 p., $45.

Newton: Ackroyd's Brief Lives



Peter Ackroyd

The book promises a personal history of Isaac Newton. Ackroyd also wrote *Shakespeare: The Biography* and *London: The Biography.*

Nan A. Talese, 2008, 176 p., $21.95.

HOW TO ORDER To order these books or others, visit www.sciencenews.org/bookshelf. A click on a book's title will transfer you to the Amazon.com bookstore. Sales generated through these links contribute to Society for Science & the Public's programs to build interest in and understanding of science.

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Television and film star Eva La Rue with her daughter Kaya

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Feedback

Plants and rheumatism

Some medical specialists in the field of rheumatology might find it useful to review the work of Ann M. Hirsch and Angie Lee, mentioned in the article by Susan Milius (*SN: 4/12/08, p. 235*). It describes a process in plant fixation of nitrogen involving biological action that seems to attract calcium. Perhaps a similar action occurs in human bone joints, causing the attraction of calcium in rheumatism.

ROGER W. OTTO, SAN MATEO, CALIF.

A pervasive hidden influence

"Dad's Hidden Influence" (*SN: 3/29/08, p. 200*) states that, "Fathers 40 and older have an increased chance that their children will develop complex disorders such as autism or schizophrenia." Our society's trend for couples to wait until they are much older to have children may be the reason for the increase in autism. The medical field tells us better identification is the reason for the increase in children being identified as mentally ill, but maybe the increase is due in part to older parents.

JULIE NELSON-THIELE, EUGENE, ORE.

Keep reverence in its place

Hats off to Ms. Ehrenberg on her "Digging that Maya blue" piece (*SN: 3/1/08, p. 134*). She didn't sugarcoat (in a politically correct manner) ancient human sacrifices as admirable religious rituals. It's bemusing that some readers feel that the practice of human sacrifice should be treated today with religious reverence. Even the Romans (who are now considered pretty barbaric) stopped religious human sacrifices in the regions they conquered more than 2,000 years ago.

BRIAN VOYCE, CHAPEL HILL, N.C.

Comments on the new *Science News:*

Eager to see the new format, but really liked the "weekly" publications. I hope the fortnightly editions are as informative. Most importantly, don't drop the Letters, as they are the first thing I read (even though you put them in the back of the weekly a few years ago). Without them I won't know if I missed anything interesting from past articles, which I do go back and review. Regards ... and cheerio.

STEVE WELLBORN, CHELLASTON, UNITED KINGDOM

Please, please, please retain the witty, lighthearted flavor of the article headlines, which have been an essential, engaging characteristic of the magazine for all the four decades I have subscribed. Thanks a lot.

FREDRIC BLUM, MERION, PA.

Good medicine (usually)

Regarding "Raising doubts about Crohn's treatment" (*SN: 3/8/08, p. 157*): My sister was diagnosed with Crohn's disease two years ago at the age of 46. She was given high doses of prednisone, which did not relieve her symptoms and which also made her depressed, extremely anxious and sleepless. After many long, scary months she was started on the infliximab-azathioprine combination, the new treatment discussed in your story. She went into remission, and the mental side effects dissipated almost overnight. She is still in remission today, a year later. But it should be mentioned that, while infliximab and azathioprine are blessings for many people, they are not benign. They have been associated with an increased risk of infection and non-Hodgkin's lymphoma.

RACHEL LEIBMAN, MONTCLAIR, N.J.

Ah-ha-ha-ha

In your article "Road to Eureka" (*SN: 3/22/08. p. 184*), you discuss "Aha!" moments. The same sort of lateral thinking and feelings occur when you "get" a joke. In fact, in parallel to when the subjects were given hints in the research your article discusses, a lack of such a moment often occurs when someone has a joke explained to them. I would not be surprised to see similar brain activity for subjects listening to jokes and perhaps even a correlation between an active sense of humor and insight. Perhaps humor and puzzle solving are a form of cross-training exercise for our brains?

ETHAN B. GALLOGLY, SANTA MONICA, CALIF.

Universal recipe

"State of the Universe: Microwave glow powers cosmic insights" (*SN: 3/15/08, p. 163*) argues convincingly and categorically that the contents of the universe consist of 23.2 percent dark matter, 72.1 percent dark energy and the rest ordinary matter. Then comes "From dark matter to light" (*SN: 3/22/08, p. 186*), where Ron Cowen writes that dark matter "appears to constitute 85 percent of the mass of the universe." Is this a radical disagreement or just conflicting guesswork, after all?

M. DAVID WOLF, SAN JOSE, CALIF.

The 85 percent refers to what share of the total amount of mass in the universe—just mass—is dark matter, while the 23.2 percent refers to what proportion of mass plus energy is dark matter. —Ron Cowen

Send communications to:
Editor, Science News
1719 N Street, NW, Washington, D.C. 20036
or editors@sciencenews.org
All letters subject to editing.

John Wheeler (1911-2008)

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Quantum theory poses reality's deepest mystery

Before his death in April, John Archibald Wheeler was one of the few remaining living legends of physics, from the generation born before the development of quantum mechanics. Wheeler collaborated with Niels Bohr, conversed often with Albert Einstein and was the doctoral professor of Richard Feynman. As a young man Wheeler worked on nuclear fission and the development of the atomic bomb. He then turned to Einstein's theory of general relativity, pioneering its use in understanding black holes (the name that Wheeler coined in 1967). In his later years Wheeler turned his inquisitive powers to quantum physics, devising imaginative experiments that helped to show how quantum reality undermines the old commonsense idea of the universe as a predictable machine. Wheeler never gave up wrestling with quantum theory's implications for the nature of reality. In interviews beginning more than 20 years ago, he articulated some of his thoughts on such matters, excerpted here.

— Tom Siegfried

You remember the words of Leibniz: *This world may be a dream. And existence may be an illusion. But to me, this dream or illusion is real enough if by using reason well we are never deceived by it.* It really doesn't say very much except that what we all know — it's real enough.

But then there's the other side of it, what this quantum business teaches us.... The world as a machine implies that there are a lot of questions we can't ask. How the machine got there, what kind of a steel press it was that pressed out the parts of it and when was the manufacture accomplished. A lot of crazy questions go with that picture. If, on the contrary, you say that everything was a matter of information, then your focus is not on machinery but on communication, which is after all how we get our knowledge — if not communication from person to person, sometimes communication from a wang or bang or hit. And that question of communication [raises] interesting things in the realm of information theory, and it looks and smells as if there will be a connection with quantum theory in the end.... It gives you the feel that you're getting hold of some new mathematics that may allow you to build up a whole structure, based on integers, based on information theory. But then how does it hook into physics as we know it? That's where the big missing gap is....

We have to learn how to use our words. It's a fantastic thing — we humans are so easily trapped in our own words. The word *time*, for instance — we run into puzzles about the concept of time and then we say, oh, what a terrible thing. We don't realize we're the source of the puzzles because we invented the word....

There's this business about [Niels] Bohr and his nice old professor [Harald] Høffding about the electron passing through the double-slit experiment [in which an electron apparently is able to pass through both slits in a barrier instead of choosing to go through only one or the other]. Bohr in his younger days, in 1927 I guess it was, was visiting Høffding in the company of [Hendrik] Casimir who had come to study with Bohr at Copenhagen. Høffding said, "In this double-slit experiment, where can the electron be said to be?" Bohr said, "To be? To be? What does it mean to be?"...

We've learned, I think, that we have to say that that is the kind of question we shouldn't be asking. Yet to say it's the kind of question we shouldn't be asking means that we have to accept a picture of the world different from what we've been accustomed to in the past, where we thought of something as chugging along that, every step of the way, you could put your finger on. We realize now that it's a wrong way of speaking, that it hasn't happened until it's been registered. You have no right to talk about where the electron is during that time....

Some people get more and more uncomfortable as they discover what quantum theory really is.... Quantum theory is the deepest part of our knowledge of nature and the biggest mystery.

Some people get more and more uncomfortable as they discover what quantum theory really is and what it says.... Einstein had discomfort with a world of that kind. As he said in the last talk he ever gave in his life, speaking to my students in a relativity seminar, "If a person, such as a mouse, looks at the universe, does that change the state of the universe?" He wanted to think of the universe as existing "out there."

Quantum theory is the deepest part of our knowledge of nature and the biggest mystery.... I think it's gradually teaching us to ask the right questions.... The only point is, will so many points of view develop that we have a disarray because it's hard to nail it down?... You get all kinds of people writing all kinds of papers with all kinds of philosophical views and backgrounds. But if you have some really sound people talking about it, I think you'll get really sound advances....

My feeling is that in this show, the territory we've got to get into is so broad that the only thing to do is to plunge into it and start making tracks, no matter if the track is leading into a swamp. You'll find out. ■

T. SIEGFRIED

"If You'd Like Sex To Be Exciting Again, This New Video Series Can Help!" – *Alana*

by Alana Pratt
Sex & Relationship Coach, TV Personality & Host Of
"Great Sex For A Lifetime"

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I am pleased to be your host throughout both DVDs. And additional important commentary is provided by two distinguished doctors, Dr. Lori Buckley and Dr. Diana Wiley (who stresses correctly that "our most important sex organ is our brain").

The BEST sex of your life is *NOT* in the past. It's there for you now, just waiting for you to embrace it, regardless of your age or how long you and your lover have been together. You deserve GREAT sex and I know you'll be enjoying it again with the help of ***"Great Sex For A Lifetime."***

Actual running time per video: 62 mins.

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