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# ScienceNews

MAGAZINE OF THE SOCIETY FOR SCIENCE & THE PUBLIC ■ NOVEMBER 8, 2008

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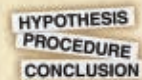
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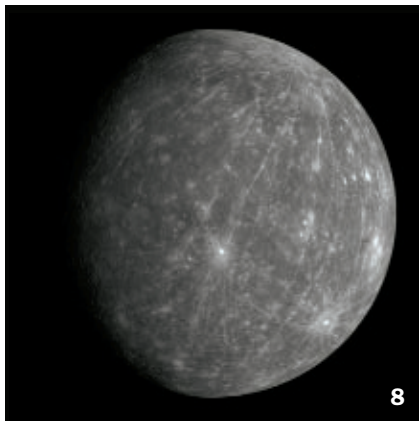
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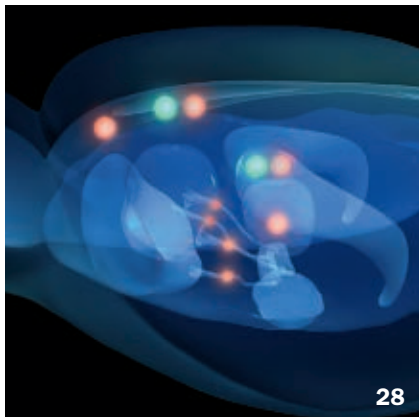
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**COVER** This advertising model for plasticizers from the 1950s shows signs of degradation on the face and hands.  
*Roberto Fortuna, National Museum of Denmark*

FROM TOP: NASA, JOHNS HOPKINS UNIVERSITY APPLIED PHYSICS LABORATORY, CARNEGIE INSTITUTION FOR SCIENCE; UPI PHOTO/CARLOS GUTIERREZ; E. R. DEGGNER/ANIMALS ANIMALS; CHARLES FLOYD

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## Chemistry's benefits go beyond 'better living'



The old slogan about “better living through chemistry” never quite captured the whole story about society's debt to the science of molecules. In some circles the phrase has even been mocked or perverted, to ridicule the plasticity of modern culture or to celebrate the abuse of psychedelic drugs.

Pollution, weapons and poisons have all been invoked to paint chemistry as a satanic science.

Defenders of chemistry's good name have always had better sense on their side, though. Apart from the consumer products and the economic opportunities in plastics alluded to by Dustin Hoffman's postgraduate adviser, chemistry provides the medicines for curing disease, the signaling systems for the brain, the substances for building and fueling the body, the foundational processes for life itself. It can't be all bad.

But, as with so much of all science, the bad is often mixed in with the good, as exemplified by nothing more clearly than nicotine. Its addictive power enslaves millions of people, condemning a substantial proportion of them to premature death. On the other hand, as freelance writer Laura Beil points out in this issue (Page 28), nicotine also offers substantial benefits, such as improving mental acuity and alleviating stress. Its popularity is not exactly inexplicable.

Nicotine exerts its influence by stimulating particular proteins in certain regions of the brain. Those proteins, or “receptor” molecules, respond naturally to the brain chemical acetylcholine, which is important for learning and memory and a number of other neural processes. That's why receptors sensitive to it come in a whole family of varieties.

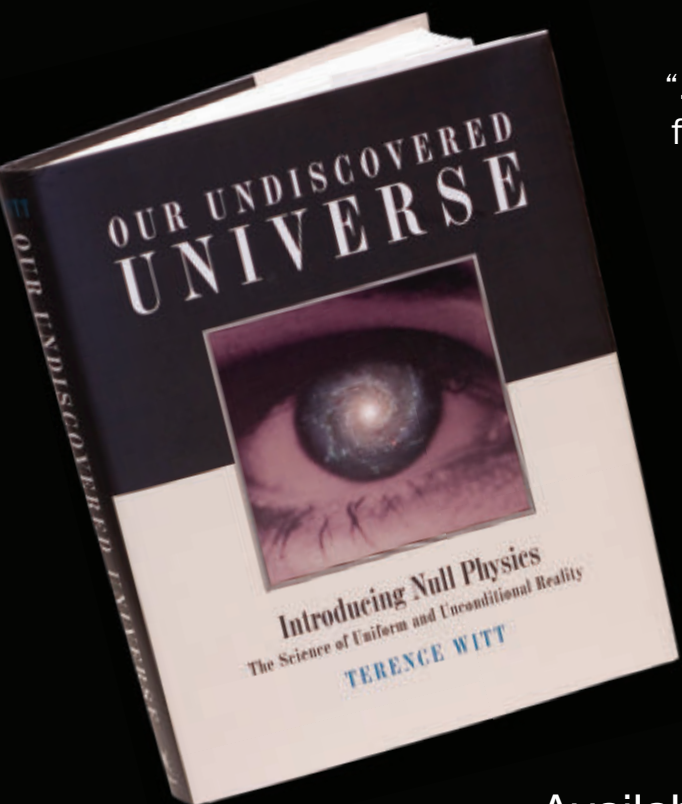
Lately neurochemists have begun to make considerable progress in learning how nicotine affects some of those receptors, and in understanding how molecules similar to nicotine might be able to achieve its positive properties without its ill side effects.

So now the search is on for new drugs that can exploit such understanding to provide better treatments for Alzheimer's disease, schizophrenia and a passel of other disorders. This endeavor is a perfect illustration of basic research's essential partnership with applied medical science, and how the cutting edge of chemical knowledge can provide insights that are useful in the service of humankind.

And chemistry's benefits aren't limited to medicine. Chemists are also on the job (Page 34) to help museums restore the degrading plastics in art and all those products from the days when *The Graduate* was Dustin Hoffman's most famous film.

—Tom Siegfried, Editor in Chief

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NEIL ARMSTRONG, IN SEPTEMBER AT A SPEECH IN WASHINGTON, D.C., COMMEMORATING NASA’S PAST 50 YEARS



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### LIFE

It’s the humans, rather than the moles, that gather to find earthworms during the annual Sopchoppy Worm Gruntin’ Festival in Florida. Research reveals a mole-of-a-reason why rubbing a piece of iron across a stake in the ground makes worms surface in droves. Read “Grunting humans, moles scare earthworms,” and watch a video of the event.

### SCIENCE & SOCIETY

Young scientists earned accolades and scholarships from the SSP Middle School Program, a national science fair that is sponsored by *Science News* publisher the Society for Science & the Public. Read about this year’s winners in “Middle schoolers earn top prizes in science competition.”

## Science Past | NOVEMBER 8, 1958

TEMPERATE ZONES MAY BE MAN’S LIMIT FOR COLD — Men living in the temperate zones had better not leave home for colder climes. The areas between the Tropic of Cancer and the Arctic Circle and between the Tropic of Capricorn and the Antarctic Circle represent the limits as far as their cold endurance goes, a scientist reports in *Nature* (Oct. 25). Persons can adapt to artificial or naturally hot environments relatively easily, says Dr. R.K. Macpherson of the division of human physiology, National Institute of Medical Research, London. However, when they are transferred from a temperate climate to a cold one, there is no comparable adaptation.... The critical [ideal] temperature for naked man is 25 to 27 degrees centigrade or about 77 degrees Fahrenheit.



## Science Future

### November 15

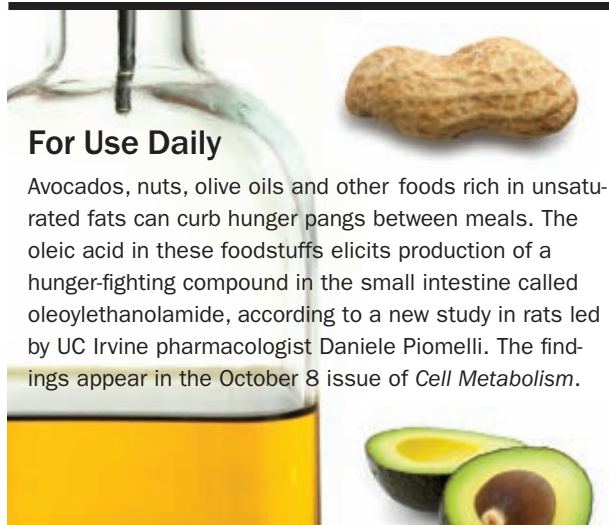
The Museum of Life and Science in Durham, N.C., unveils its holiday mechanical sculpture display. Visit [www.ncmls.org](http://www.ncmls.org)

### November 20

“Irreplaceable: The World’s Most Invaluable Species” debate held in London. Visit [www.earthwatch.org/europe](http://www.earthwatch.org/europe)

### December 15–18

20th International Conference on Magnetically Levitated Systems and Linear Drives in San Diego. Visit [www.maglev08.com](http://www.maglev08.com)



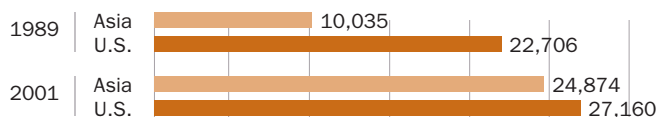
## For Use Daily

Avocados, nuts, olive oils and other foods rich in unsaturated fats can curb hunger pangs between meals. The oleic acid in these foodstuffs elicits production of a hunger-fighting compound in the small intestine called oleoylethanolamide, according to a new study in rats led by UC Irvine pharmacologist Daniele Piomelli. The findings appear in the October 8 issue of *Cell Metabolism*.

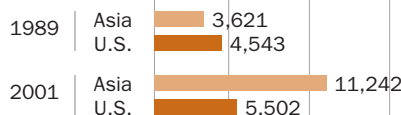
## Science Stats | PRODUCING PH.D.S

Science and engineering doctorates awarded in Asia compared with the United States in 1989 and 2001.

### All Science and Engineering



### Engineering



SOURCE: “ASIA’S RISING SCIENCE AND TECHNOLOGY STRENGTH,” NSF 2007 REPORT

“ This really stands one of the basic tenets of microbial ecology on its head. ” —CARL PILCHER, PAGE 20

**Atom & Cosmos** Mercury's crater face

**Numbers** Dealing with infinite choices

**Humans** Clues to TB in ancient bones

**Life** More mammals face extinction risk

**Earth** Stalagmites suggest shaky past

**Body & Brain** Right hand reclaims brain

**Genes & Cells** Only the lonely bacteria

# In the News

STORY ONE

## Poaching's long reach threatens elephants anew

Killing surges, effects linger years after ivory trade banned

By Rachel Ehrenberg

It's a tough time to be an African elephant. Despite an international ban on ivory trading, the animals are being slaughtered for their tusks at a greater rate today than before the ban was enacted in 1989. At the same time, scientists are learning that the traumatic effects of the death of close relatives — especially for female elephants — may echo through the fragmented families for decades.

“These solitary females just finally had daughters — they're trying to raise families. And they are just going to get mowed down again,” says Kathleen Gobush, lead author of a new study that examines the long-term effects of poaching.

While scientists are documenting poaching's lasting effects, they are also making headway with forensics research that may help thwart poachers.

“Elephants are extremely important to ecosystems in Africa. They manipulate habitat; they keep savannahs, savannahs,” says Samuel K. Wasser, director of the Center for Conservation Biology at the University of Washington in Seattle. “When you reduce the elephant population, it is hugely disruptive to their social structure and physiological health — and it takes a huge amount of time to recover.”

Two new studies document the toll of



**Female African elephants (*Loxodonta africana*) live in family groups led by matriarchs. Losing the older females to poaching leaves survivors more stressed, new studies show.**

those disruptions. One, published online in *Conservation Biology* and based on Gobush's Ph.D. work with Wasser, looks at the family structure, stress hormone levels and reproductive output of more than 200 female elephants in Mikumi National Park in Tanzania. This area lost an estimated 75 percent of its elephants to poaching before the ivory ban. (Typically, 6 percent of a population is tuskless, because of a genetic quirk. Today in Mikumi about 15 percent are tuskless.)

Elephants have intricate social networks, dominated by female matriarchs, explains Joyce Poole, who has studied the

Mikumi population. Females and young males generally travel and live in groups. When they spend time apart, reunions are marked by “greeting ceremonies,” entailing throat rumbles, rapid ear flapping and a clanging of tusks.

The older females — African elephants can live to about 65 — are “the glue that holds the family together,” says Poole, director of research and conservation for ElephantVoices. Faced with a threat, younger elephants turn to the matriarch to determine if they should fight or flee. Daughters typically stay with their moms their whole lives. >>



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» Gobush examined more than 100 family groups; about 59 percent had an old matriarch. The families were roughly distributed among six populations, each centered around a watering hole. Four populations were designated high-risk, having been heavily poached in the past.

Analysis of fecal hormone levels and DNA revealed that female elephants in groups lacking a matriarch or closely related relatives had higher levels of stress hormones known as glucocorticoids. The spiked hormone levels were especially pronounced in elephants dwelling in areas where past poaching was greatest. Females from these disrupted groups were also less likely to be pregnant or have an infant.

"If you are in a high-risk area and you lack family, that solid group unit, that's when you're in trouble," says Gobush, now with the National Oceanic and Atmospheric Administration in Honolulu.

The findings suggest that a disrupted family group is a chronic stress condition, which can be exacerbated by other factors, such as lack of rain.

Calling the results "very well-integrated," biologist Susan Alberts of Duke University in Durham, N.C., says the work



**With the price of ivory skyrocketing, elephants are being killed at a faster rate now than before the ivory ban.**

shows that, "If the family is disrupted, it is going to be 30 years before the family is intact again."

A separate study by Charles Foley of the Wildlife Conservation Society and

his colleagues investigated the survival of elephant calves during extreme drought. Fewer calves died in groups with an experienced mother. Old matriarchs appear to give a survival edge to the group, perhaps by remembering the location of distant water in hard times, the researchers report online in August in *Biology Letters*.

Elephants have a "tremendous interest in and awareness of death," Wasser says. They spend an inordinate amount of time sniffing bones, passing over non-elephant skeletons. Researchers, including Poole, have described heightened elephant-on-elephant aggression and the killing of rhinoceroses by young male elephants that, because of poaching, lacked older male role models. Introducing old males to the area stopped these behaviors, probably by suppressing musth, a period when testosterone in males surges, Poole and others wrote in *Nature*.

In the decade before the ivory ban, the number of African elephants plummeted from roughly 1.3 million to fewer than 600,000. For a few years, the ban seemed to keep things in check. But then funding for wildlife law enforcement dropped and roads for logging and drilling opened vast, previously impenetrable tracts of the forest to poachers, Wasser says.

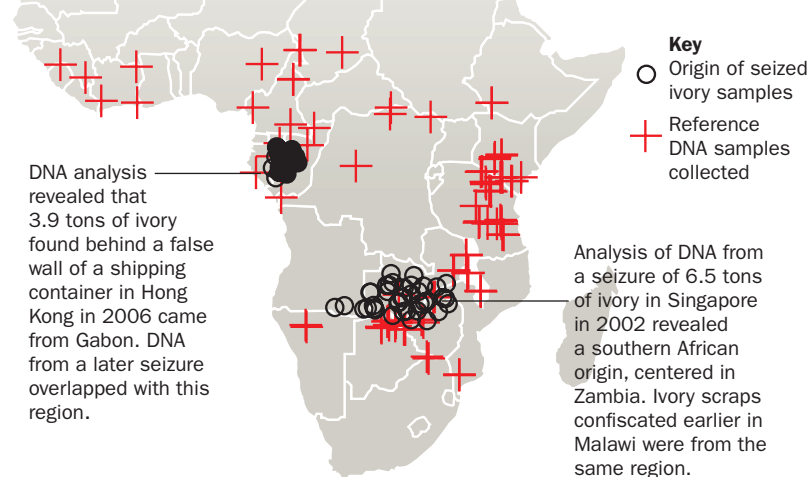
"Poaching is the worst in history right now," he says. Before the ban, about 7.4 percent of the elephant population was being killed for ivory each year. Estimates suggest the rate is now 8 percent, which could bring the animals close to extinction by 2020.

Illegal wildlife trade has metastasized in this global trade era, with a mere 1 percent of shipping containers typically inspected by customs, says Wasser. Yet compared with drugs or weapons, wildlife trafficking is a low priority for law enforcement and thus low-risk for criminals. Since 2004 the wholesale price of ivory has more than quadrupled from roughly \$200 per kilogram to \$850 per kilo in 2007.

"Law enforcement can't win this fight," says Wasser. "It is hopeless. Enforcement will admit that without batting an eye." ■

## Back Story | POACHING HOT SPOTS

New work by Samuel K. Wasser and colleagues may help stymie poachers by pinpointing the origins of seized ivory shipments. The analysis uses more than 600 reference samples of elephant DNA and incorporates the fact that elephant populations living near each other have more similar DNA than populations that are farther apart. The resulting genetic map suggests that poachers are hitting the same spots over and over again.





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## NASA attempts to wake up Hubble

It's on-again, off-again for the veteran space telescope

By Ron Cowen and Laura Sanders

NASA engineers continue to struggle to revive the Hubble Space Telescope, which fell silent on September 27 after the failure of a data formatting unit. The unit helps label and relay information broadcast to Earth. Since the late September failure, Hubble has been performing only basic maintenance tasks, with almost all of its science observations suspended.

On October 15, engineers attempted to restore the stream of science data by switching operations from the damaged formatting unit to a duplicate backup device. Early indications were positive: Key instruments including the Advanced Camera for Surveys, the Wide Field Planetary Camera 2 and the Near Infrared Camera and Multi-Object Spectrometer



Hubble has been in orbit since 1990.

were successfully turned on and able to communicate through the backup for a brief moment before engineers returned them to their quiescent state.

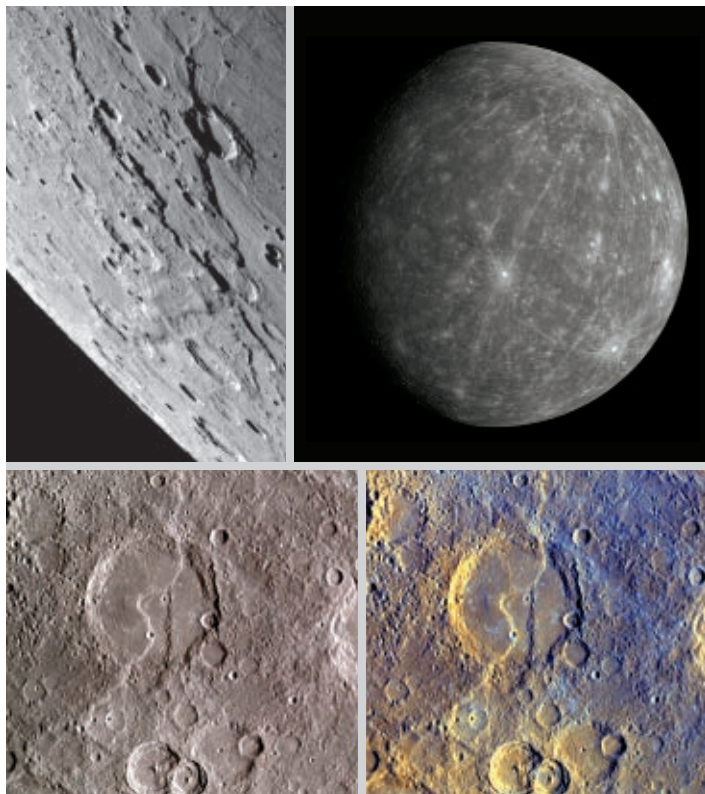
But the next day, system monitors indicated that a power supply to the Advanced Camera for Surveys' only operating instrument, the Solar Blind Camera, had failed to reach the correct voltage. In addition, another, yet-unidentified electrical

problem occurred that briefly interrupted power to the backup unit, sending all of Hubble back into hibernation.

At press time, engineers were waiting for NASA's go-ahead to reactivate the backup formatter and begin another attempt to revive Hubble. The reactivation process might begin October 24, said Hubble senior project scientist David Leckrone of NASA Goddard Space Flight Center in Greenbelt, Md.

Even if Hubble is reactivated, it still won't have its full complement of instruments operating. Most observations with the Advanced Camera for Surveys haven't been possible since a short circuit developed in early 2007.

In addition, because of a more recent glitch, the Near Infrared Camera and Multi-Object Spectrometer will not be immediately operating and NASA might not attempt to revive them until a shuttle servicing mission now delayed until February.

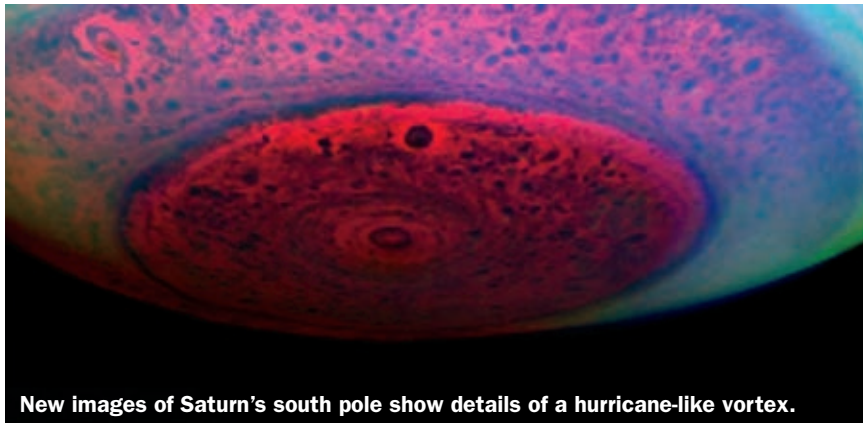


## Other side of Mercury

Mercury, the solar system's forgotten planet, got back into the limelight on October 6 when the MESSENGER spacecraft flew past for a second time, revealing 30 percent of the crater-scarred body that had never before been seen in detail (top right). The top left picture shows a large scarp slicing through a crater, indicating that the ridge likely formed after the crater. The pair of images of Thākur, a 118-kilometer-wide crater, highlights color variations in the soil. The grayish image on the bottom left shows Thākur as the eye would see it, while the bottom right image combines visible light and near-infrared data taken through 11 filters in a manner that reveals compositional differences in Mercury's rocks. Such color-enhanced images may ultimately shed light on the processes that created those variations in composition, says MESSENGER principal investigator Sean Solomon of the Carnegie Institution for Science in Washington, D.C. Solomon unveiled the crater images on October 14 in Ithaca, N.Y., at the annual meeting of the American Astronomical Society's Division for Planetary Sciences. MESSENGER will fly past Mercury again in September 2009 and settle into orbit around the planet in 2011. — Ron Cowen

FROM TOP: NASA; STSCI; NASA, JOHNS HOPKINS UNIVERSITY APPLIED PHYSICS LABORATORY, CARNEGIE INSTITUTION FOR SCIENCE, ARIZONA STATE UNIVERSITY

“We are still in the phase of butterfly collecting, trying to classify what we see.” — ANDY INGERSOLL



New images of Saturn's south pole show details of a hurricane-like vortex.

## Superstorms swirl at Saturn's poles

Cassini images offer closer look at ringed planet's cyclones

By Ron Cowen

ITHACA, N.Y. — Hurricanes Ike and Katrina can't hold a candle to the giant storms on Saturn. Polar cyclones on the ringed planet are big enough to engulf Earth. The closest look yet at the storms comes from images taken in July by the Cassini spacecraft, scientists reported October 13 at a meeting of the American Astronomical Society's Division of Planetary Sciences.

Unlike Earth's hurricanes, which drift across oceans, these storms are locked to Saturn's poles. The storms may be driven by Saturn's internal heat, which creates giant weather patterns by causing parcels of atmospheric gases to rise and fall. It's also possible that sunlight trapped in the planet's atmosphere could drive the motions, says Andy Ingersoll of the California Institute of Technology in Pasadena.

“We are still in the phase of butterfly collecting, trying to classify what we see,” Ingersoll says.

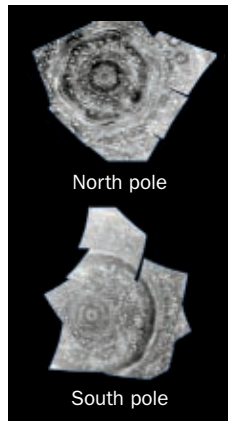
At Saturn's north pole, the new Cassini portraits reveal a previously unknown cyclone. Because this pole is now in win-

ter and receives no sunlight, the cyclone can be seen only at infrared wavelengths, where the glow from Saturn's internal heat silhouettes thick, swirling clouds.

Surrounding this cyclone is a puzzling hexagon-shaped structure, first seen by the Voyager spacecraft more than 20 years ago, and imaged by Cassini last year. Although the hexagon itself is stationary, small white clouds inside the structure move at speeds exceeding 500 kilometers per hour, whipping around the hexagon like cars on a racetrack, says Ingersoll.

At the south pole, where it is summer, Cassini took images in infrared and visible light. The new images show features one-tenth the size of those seen before. Previous visible-light images showed an outer ring of high clouds surrounding what appeared to be a relatively cloud-free region, but the new close-ups reveal a second, inner ring of strong storms.

Other planets, such as Neptune, show signs of possible storm activity at the poles, but observations from Earth are too poor to discern detailed structures, says Heidi Hammel of the Space Science Institute in Boulder, Colo. ■



Infrared images show Saturn's cyclones.

### Meeting Notes

Division for Planetary Sciences  
October 10–15, Ithaca, N.Y.

#### So near, so far away

Long-distance relationships are tough enough when partners are a continent apart. Consider the plight of two solar system bodies separated by a distance more than 20 times as great. Jean-Marc Petit of the Besançon Observatory in France and colleagues have found two equal-mass members of the Kuiper Belt that are gravitationally bound to each other but separated by a distance greater than that of any other pair of small bound bodies in the solar system. —Ron Cowen

#### A comet doubleheader

When comet 8P/Tuttle passed close to Earth early this year, astronomers took its portrait with the Arecibo radio telescope in Puerto Rico. To their surprise, the radar images have revealed that the comet consists of two chunks that appear to be held together by a narrow neck of material. The portrait suggests that the body is the first known example of a comet of its kind. —Ron Cowen

#### Sniping at Jupiter

Jupiter, thought to protect the inner planets from space debris, may sometimes hurl material toward Earth. Modeling 40,000 planetesimals, Kevin Grazier of NASA's Jet Propulsion Laboratory in Pasadena, Calif., and colleagues found that close gravitational encounters with outer planets, especially Jupiter, kicked some objects into the inner solar system. Not all of these potshots were destructive; some of the material contained water and other compounds that could have helped life gain a foothold. —Ron Cowen

# Numbers



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## Nash's math gets more beautiful

### Even with infinite choices, games may have stable strategies

By Patrick Barry

Life's a game, or at least treating it like a game mathematically can be a powerful way to explain the choices people make. John Nash, the mentally troubled mathematician depicted in the book and movie *A Beautiful Mind*, discovered one of the bedrock theories for understanding competitive interactions (generically called "games") in which players have a limited set of choices.

Now mathematicians are expanding Nash's idea to cases when the players' options are infinite. Under certain conditions, infinite-choice games are guaranteed to have at least one scenario in which each player's choice gets that player the best deal possible (given everyone else's choices), according to a proof to be published in the February 2009 *Nonlinear Analysis*.

Such a scenario is called a Nash equilibrium. It is stable because no player can do any better by changing strategy. Like a rock at the bottom of a valley, a game reaching this stable scenario should tend to stay that way. In a sense, it's the fate of the game to end up at a Nash equilibrium, and this predictive power is why Nash's ideas have become widely used in economics and other social sciences.

Nash proved that there is always at least one such equilibrium for games with a finite number of strategic choices. But not all possible games are so limited.


"There are many economically important games in which the sets of pure strategies are infinite," comments Andy McLennan, a mathematician and economist who studies game theory at the University of Queensland campus in St. Lucia, Australia. McLennan offers the example of an auction in which each bidder can bid any amount — mathematically, an infinite set of numbers. Of course, enormous bids would be very

poor strategies in real life, but the math for modeling these situations must take all possible strategies into account.

A theory that always predicts whether an infinite-choice game will have a Nash equilibrium still eludes mathematicians. In the new work, Jinlu Li, a mathematician at Shawnee State University in Portsmouth, Ohio, and colleagues deal with a special case. If all the possible scenarios for a game are "compact" — meaning that they are somehow constrained even if

there are infinitely many of them — the game will have at least one Nash equilibrium, the team shows.

"This paper is still far away from completely solving this problem," Li says. The new rule doesn't fully predict which infinite-choice games will have an equilibrium; some games that aren't compact also will have one.

The work is also based on a simplified game with only two players, in which for one player to win, the other must lose. Nash's theorem for finite-choice games works for much more complex games involving many players and the possibility of mutual benefit. 

## The numbers rarely add up for girls

### Culture may turn potentially high achievers away from math

By Davide Castelvecchi


A combination of peer pressure, gender stereotyping and low expectations may help turn potentially gifted kids — especially girls — away from mathematics, wasting a country's precious national resource, a new study suggests.

The study, by biochemist Janet Mertz of the University of Wisconsin–Madison and colleagues, appears in the November *Notices of the American Mathematical Society*.

Mertz's team tallied the participants in top international competitions for high school students — the William Lowell Putnam Mathematical Competition and the International Mathematical Olympiad — and other data. Girls were underrepresented on all countries' teams, and some teams, including the United States, had no girls in some years.

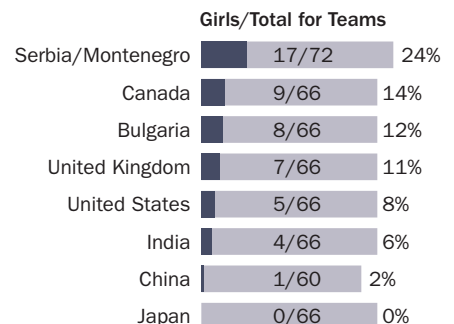
The large discrepancies among teams point to cultural causes, Mertz says. "It's not that girls don't have the intrinsic aptitude to excel at this level," she says, "but that something's happening in the U.S. to inhibit it." In part, it may be people's attitude, she says.

"They still believe this myth that girls can't excel at math." Youth culture also may have an impact, branding students' — not just girls' — interest in math as "uncool," the researchers write.

"It certainly resonates with my experience," says Melanie Wood, who in 1998 became the first female member of the U.S. International Mathematical Olympiad team and is now a graduate student in mathematics at Princeton University. "There's no question that doing math — and doing math for fun — was considered nerdy," especially for a girl, Wood recalls of her grade-school years. 

### Uneven girl power

Total number of girls on International Mathematical Olympiad teams, years 1998–2008





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# Humans



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## Skeletons harbor ancient evidence for tuberculosis

DNA shows disease arose before cattle domestication

By Bruce Bower

TB or not TB? That was the question created by two human skeletons excavated more than a decade ago at a 9,000-year-old village submerged off Israel's coast.

Bone damage apparently produced by some infection created the Shakespearean dilemma that puzzled anthropologist Israel Hershkovitz of Tel Aviv University.

Thanks to a genetic analysis of the skeletons directed by Helen Donoghue and Mark Spigelman, both of University College London, Hershkovitz now knows that his team unearthed the earliest known cases of human tuberculosis. A roughly 25-year-old mother had appar-



**DNA analyzed from 9,000-year-old sunken bones suggests tuberculosis appeared in humans earlier than thought.**


ently passed the bacterial infection on to her 1-year-old child, after which they both died and were buried together.

Examination of DNA from the skeletons supports the idea, based on earlier studies, that bovine tuberculosis evolved after

human tuberculosis did, Hershkovitz and colleagues conclude in a report published online October 15 in *PLoS ONE*.

Work at the village of Atlit-Yam, which has been covered by water for thousands of years, yielded skeletons and some of the oldest evidence for farming and cattle domestication.

Infection-related bone damage is difficult to pin on any specific disease, notes biological anthropologist George Armelagos of Emory University in Atlanta. "The genetic analysis of the Atlit-Yam skeletons really opens up our understanding of the human form of tuberculosis by showing that it was not derived from cattle but evolved well before animal domestication," Armelagos says.

One hypothesis holds that tuberculosis initially infected people who drank milk from domesticated cattle carrying a unique strain of the bacterium. The Atlit-Yam data "give us the best evidence yet that in a community with domesticated animals but before dairying, the infecting strain of tuberculosis was actually the human pathogen," Donoghue says. 

## Rumors shaped veterans' view of Gulf War ills

Syndrome was defined by informal communication

By Bruce Bower

After the bullets stopped flying, the rumors took off among British veterans of the 1991 Gulf War. Early accounts of physical and emotional reactions to wartime experiences spread from one person to another through networks of veterans. Within a few years, these former soldiers had decided among themselves that the symptoms they were suffering from collectively amounted to the controversial illness known as Gulf War Syndrome, a new study concludes.


Simon Wessely of King's College London and his colleagues analyzed extensive written accounts provided in 1996 by 1,100 British Gulf War vets.

The research team doesn't regard the rumors as necessarily untrue or misleading. Rumor proved to be critical among the British Gulf War vets because it counteracted a lack of communication from military and government authorities, Wessely says. Vets turned to their own social grapevine for answers, Wessely's group reports in a paper to appear in *Social Science & Medicine*.

Symptoms attributed to Gulf War Syndrome include joint and muscle pain, bouts of depression or violent behavior, and various cancers. Some researchers regard the condition as a psychological disorder related to combat stress. Others contend that it's a physical disorder caused by exposure to toxic substances.

Wessely says current medical consensus holds that the veterans do display high rates of various health problems, but these conditions don't constitute a discrete illness.

In a commentary to be published with the new study, Thomas Shriver of Oklahoma State University in Stillwater and Sherry Cable of the University of Tennessee in Knoxville say that Wessely's team appears to regard veterans' symptoms as purely psychological and perhaps partly invented out of rumor. "The authors come perilously close to blaming the victims," the two sociologists contend.

But, Wessely responds, "Far from blaming vets, we are shifting the spotlight to the role of governments in allowing an information vacuum to develop regarding potential health risks, which allowed rumors to spread and gain currency after the war." 



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## Primordial soup returns to life

Vials from '50s hold hints of volcanic birth for amino acids

By Laura Sanders

After decades of languishing in a cardboard box, unanalyzed vials from a famous chemistry experiment have been brought back to the lab, revealing new clues to the beginnings of life on Earth.

Over 50 years ago, 23-year-old graduate student Stanley Miller conducted an experiment with his adviser, Nobel laureate Harold Urey. They showed that amino acids, the building blocks of proteins, could be made from a cocktail of basic chemical precursors, the “primordial soup.”

Now a team led by Miller’s former graduate student Jeffrey Bada reports that remnants from a variation of that experiment, designed to simulate a volcanic environment, contain even more biologically important amino acids.

Urey and Miller re-created what they thought was the atmosphere of early Earth—a stew of methane, ammonia, hydrogen and water—and zapped the contents with an electric shock similar to lightning. After a night of sparking,



**A bolt of lightning in a volcanic environment could have led to an abundance of amino acids, possible precursors to early life.**

the vial turned red, then yellow and finally brown. Analyses confirmed the presence of amino acids, which were a major focus in the search for the origins of life.

Miller published his results in *Science* in 1953. Bada’s team reported the new results in the Oct. 17 *Science*.

Before Miller died last year, the contents of his lab, including experiments and notebooks, were moved to Bada’s laboratory at Scripps Institution of Oceanography in La Jolla, Calif. When Bada heard of the existence of the vials, he began digging through the boxes.

Bada and biochemist Adam Johnson of Indiana University in Bloomington discovered that some of the vials’ con-

tents were created in the presence of a stream of water vapor, which simulated the local environment of a volcano. The team reconstituted and analyzed the dried material in these vials, identifying 10 types of amino acids not found in the original experiment.

That result makes it plausible that a shallow primeval tide pool tucked into the side of a volcano and a fortuitous bolt of lightning could have led to an abundance of amino acids, Bada says.

“The local volcanic scenario is clearly more favorable for synthesis than the classical version of this experiment,” says Alan Schwartz of Radboud University Nijmegen in the Netherlands.



## No dad needed

DNA analysis reveals that blacktip sharks like this one may be able to reproduce without a mate. The same team of geneticists that verified the first “virgin birth” among sharks in a small hammerhead in May 2007 has confirmed a sex-free pregnancy in a *Carcharhinus limbatus* from the Virginia Aquarium. The finding, published in the Oct. 10 *Journal of Fish Biology*, suggests that many female sharks may be able to reproduce asexually through a process found in Komodo dragons and some birds. The researchers studied mother-to-be “Tidbit” after she had died, finding a well-developed embryo—even though Tidbit had not been near male blacktips for eight years. Lead author Demian Chapman of Stony Brook University in New York notes that this type of reproduction has given rise only to single female litters with decreased genetic diversity. — *Dina Fine Maron*

FROM TOP: UPI PHOTO/CARLOS GUTIERREZ; MATTHEW D. POTENSKI



**10** meters | Longest known modern-day snake, the reticulated python

**0.1** meters | Smallest known snake species, *Leptotyphlops carlae*

## Mammals encounter tougher times, new assessment of species shows

Latest report finds more than a fifth face extinction threat

By Susan Millius

Between a fifth and a generous third of the world's mammal species now face the threat of extinction, according to the first comprehensive review since 1996.

Now 1,139 species rank in the most imperiled categories, the conservation monitoring organization IUCN reported October 6 in Barcelona at its World Conservation Congress and in the Oct. 10 *Science*. Data from more than 1,700 experts went into this five-year review of the conservation status of all known wild mammals for the IUCN Red List of Threatened Species, the main global scorecard for extinction risk.

"All in all, a major event," says Don



Tasmanian devils move to endangered status.

Wilson, a mammal curator at the Smithsonian Institution in Washington, D.C.

IUCN reviewed mammals' status in 1996, but things have changed since then, says one of the leaders of the effort, conser-

vation ecologist Jan Schipper, who works with IUCN and Conservation International. Tasmanian devils, for example, have shifted from the "least concern" category into the endangered one. Their population shrank some 60 percent during the past decade as an infectious face cancer spread through the species. And shrinking wetlands in Asia pushed the fishing cat from a vulnerable ranking to the endangered category.

Assessment methods have changed too. Reclassification based largely on DNA has split some of the species listed in 1996 and lumped together others.

"One of the things that surprised me the most was that there are still 836 species that are data-deficient," Schipper says. Biologists know mammals relatively well, but hundreds remain so mysterious that the species experts couldn't assess conservation status.

If those mystery species are doing just fine, a situation Schipper considers improbable, then 21 percent of the currently known 5,487 mammal species face a serious threat of extinction. If all the little-known species turn out to be faltering too, that would mean 36 percent of known mammals are in trouble.

"We don't want to say, 'the sky is falling,'" Schipper says. To avoid sensational opinions, the IUCN sets quantitative criteria for the tally's three worrisome categories of animals threatened with extinction: critically endangered, endangered and vulnerable. Even the least threatened among these, the vulnerable species, meet one of several thresholds, such as losing more than a third of their population during either a decade or over three generations, whichever is longer.

In the new review, habitat loss or degradation ranks as the most widespread threat, grinding down the populations of some 40 percent of species studied. Hunting for food, for medicinal use and for other purposes affects 17 percent of mammal species, the researchers say.

## Fossil find may reveal history's largest snake

Serpent exceeded 1 ton, extended nearly 13 meters

By Sid Perkins

CLEVELAND — Rocks beneath an open-pit coal mine in Colombia have yielded fossils of what could be the world's largest snake, a relative of today's boa constrictor that was 12.8 meters long.

Few of today's snakes exceed 9 meters, says Jonathan Bloch, a vertebrate paleontologist at the University of Florida in Gainesville. Some snakes that lived about 60 million years ago, however, would have dwarfed their modern kin, he reported October 15 at the annual meeting of the Society of Vertebrate Paleontology.

At a site in northern Colombia, Bloch

and his colleagues unearthed the partial remains of an ancient snake. Each of the dozen or so vertebrae in that body segment measured about 10 centimeters across, about twice the width of the largest vertebra in a 6-meter-long modern anaconda, Bloch notes.

None of the ribs in the fossil are complete, but the size and curvature of the fragments indicate that the snake "would have had trouble fitting through the door into your office," he adds. The fossils represent an as yet unnamed species.

The scientists can't readily tell whether the segment they unearthed came from the thickest portion of the snake, so estimates of the snake's size and weight are minimum values. The researchers contend that the snake they discovered could have stretched more than 12.8 meters and weighed at least 1.27 metric tons.

"This [snake] is definitely bigger than any modern-day snake," says S. Blair Hedges, an evolutionary biologist at Pennsylvania State University in University Park.



## Stalagmites tell earthquake history


Caves could yield insight into timing of Midwestern temblors

By Sid Perkins

HOUSTON — The dates at which some Midwestern cave formations began to grow could help researchers chronicle the earthquake history of Missouri and surrounding states, scientists reported October 5 at the annual meeting of the Geological Society of America.

In 1811 and 1812, major quakes rocked the New Madrid Seismic Zone, a fault system named for a Missouri town. Keith C. Hackley, a geochemist with the Illinois State Geological Survey in Champaign, and his colleagues have used geochemical techniques to analyze material at the base of stalagmites found in caves between 180 and 230 kilometers north of the epicenters of the 1811 and 1812 quakes. Many of those stalagmites started growing about 195 years ago, when massive temblors — around magnitude 8 — may have

cracked rocks overlying the caves. When these rocks cracked, mineral-rich groundwater seeped into the caverns and started generating new stalagmites. Other stalagmites that the team analyzed began growing about 90 years ago, around the time that a magnitude 5 quake shook a region just east of the caves, says Hackley.

These results hint that stalagmites could provide useful data about ancient quakes in the area, Hackley says. 



**Stalagmites in Illinois Caverns, near St. Louis, could chronicle regional quakes.**

## A near-record Arctic melting


Sea-ice coverage increases, but remains below normal

By Sid Perkins

This summer, the share of the Arctic Ocean covered by sea ice was the second lowest since satellite measurements began in 1979. Because much of the ice had formed just this past winter and was relatively thin, the volume of floating ice at the top of the world probably reached a record low, scientists estimate.

The area of the Arctic Ocean for which floating ice covers at least 15 percent of the sea's surface — a measure called sea ice extent — fell to 4.67 million square kilometers this past September. That's 9 percent higher than last year's record-


low value (*SN: 10/13/07, p. 238*), but 34 percent below the September average since 1979, says Walt Meier, a remote sensing analyst at the National Snow and Ice Data Center in Boulder, Colo. Sea ice extent has declined 11.7 percent per decade since 1979, Meier and colleagues report in an October 2 news release.

In March 2008, after a winter recovery from last year's record-low ice coverage, thin first-year ice covered a record-high 73 percent of the Arctic Ocean. First-year ice is more prone to break up and melt than thicker, multiyear ice. Ice loss, in turn, primes the ocean to warm even further: Open water absorbs about 90 percent of the sunlight that falls on it; snow-covered ice reflects 70 to 90 percent (*SN: 11/12/05, p. 312*). Then, when ice breaks up, it's bathed in warm water on several sides, not just on the bottom — a scenario that accelerates melting even further, says Meier. 


### Meeting Notes

#### Geological Society of America October 5–9, Houston


##### Trees grew fast in Antarctica

Trees in Antarctica long ago had a growth pattern much different from modern trees, a new study finds. Today, trees in temperate climates have annual growth rings no wider than 2 millimeters. But some fossils of 255-million-year-old trees from Antarctica have growth rings close to 10 millimeters wide, Patricia E. Ryberg and Edith L. Taylor of the University of Kansas in Lawrence report. —Sid Perkins 

##### Salinity sensors

Mussels could help researchers monitor road-salt pollution in streams, a new study suggests. As the carbonate shells of freshwater mussels such as *Elliptio complanata* grow, they record changes over time in growth rings just as trees do. So the mussels could serve as biological sensors of a stream's water chemistry, Matthew Winnick of Vassar College in Poughkeepsie, N.Y., and his colleagues report. —Sid Perkins 

##### Largest tsunami debris

Seven immense boulders of coral found far inland on a Tongan island may be the world's largest tsunami debris, new research shows. All evidence hints that the boulders, which lie inland of a 3-kilometer stretch of coastline, are out of place, says Matthew J. Hornbach of the University of Texas at Austin. Some of the coral masses are oriented sideways or upside down instead of upward, facing the sun, testifying to an exotic origin. —Sid Perkins 

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Modern light fixtures do little to overcome problems associated with improper lighting, such as eyestrain, dryness, and burning. As more and more of us spend longer and longer hours in front of our computer monitor, these problems are compounded. And the effects of improper indoor lighting are not necessarily limited to a physical problem: the quantity and quality of light can also play a part in both our mood and work performance.

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# Brain sensory region reactivated decades after hand amputation

Transplant restores partial use of original neural pathway

By Bruce Bower

David Savage probably never expected to look down and see someone else's hand attached to his right arm. Neither did he anticipate using the strange appendage to illuminate how the brain works. But that's precisely what the hand-transplant patient, now 56, has done.

Four months after his December 2006 transplant, Savage's partial sense of touch in the new hand activated the same brain area that would have controlled his original right hand 35 years earlier, say neuroscientist Scott Frey of the University of Oregon in Eugene and colleagues.

When Savage had both hands, part of his right brain responded to his left hand, and a corresponding part of his left brain responded to his right hand. But after the amputation of his right hand following a machine-press accident at age 19, that same part of his left brain would have been sensory-deprived. It would have adopted duties of adjacent sensory areas, such as those for the right arm and possibly face.

Much research has documented that such neural reorganization begins within hours of limb loss or debilitation.

Yet decades later, with a new hand in place, the former "hand area" of


Savage's brain has reclaimed its old territory, Frey's team reports in the Oct. 14 *Current Biology*.

"The capacity of the brain to reverse reorganizational changes is all the more striking in light of the fact that his brain was fully mature when the amputation occurred," Frey says.

Although the researchers have no data about Savage's brain from just before or just after the amputation, sensory areas responsible for his missing right hand must have assumed new duties, says neuroscientist Jon Kaas of Vanderbilt University in Nashville. At a minimum, the neural map for Savage's right hand would have begun to respond to stimulation of parts of his right arm, Kaas suggests.

"It's remarkable that an original neural pathway for the hand can be reinstated after years and years," Kaas says.

In April 2007, functional MRI recorded Savage's brain activity while each of his hands, along with each of his cheeks, was stroked with a coarse sponge. The same experiment was carried out on four men who had never experienced an amputation. Savage reported full left-hand and full facial sensation, as well as sensation in his right palm near the thumb. During right-hand testing, Savage displayed much the same left-brain activation that the other men did.


Savage's recovery so far is limited to major nerves in the right hand, not to peripheral nerve connections for individual fingers, Frey says. It's unclear how the neural map of the right hand will adapt as Savage's finger nerves regenerate and finger sensation develops. 




Within months of receiving a hand transplant in 2006 (left), David Savage regained sensation in his palm. A year later, he was able to lift a weight (right).

## News briefs


### Protecting newborns from flu

A pregnant woman who gets a flu shot passes protection on to her fetus, lessening the newborn's likelihood of contracting flu, researchers report in the Oct. 9 *New England Journal of Medicine*. Until now, no randomized trial has evaluated the shot's effectiveness in a clinical setting. "If you want to protect the baby and be careful, maybe the vaccine is a way to do that," says study coauthor Mark Steinhoff of Johns Hopkins University in Baltimore and the Cincinnati Children's Hospital Medical Center. — *Nathan Seppa* 

### Bad air for growing brains

Mexico City's dirty air may contribute to brain inflammation and intellectual deficits in school-age children, a new study suggests. Among healthy children aged 7 to 18, lifelong Mexico City residents scored lower than peers from a less-polluted city on tests of memory, flexible thinking, problem-solving skill and the ability to monitor and change behavior during challenging tasks, Lilian Calderón-Garcidueñas of the University of Montana in Missoula and colleagues report in an upcoming *Brain and Cognition*. — *Bruce Bower* 

### Vitamin D deficiency

A vitamin D shortage is more likely in people with Parkinson's disease than in healthy people or those with Alzheimer's, a study in the October *Archives of Neurology* suggests. Blood samples showed a deficiency in 55 percent of Parkinson's patients, 41 percent of Alzheimer's patients and 36 percent of healthy subjects. Differences may be linked to less sun exposure in Parkinson's patients, says coauthor Marian Evatt of Emory University in Atlanta. — *Nathan Seppa* 

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## Gold mine houses community of one

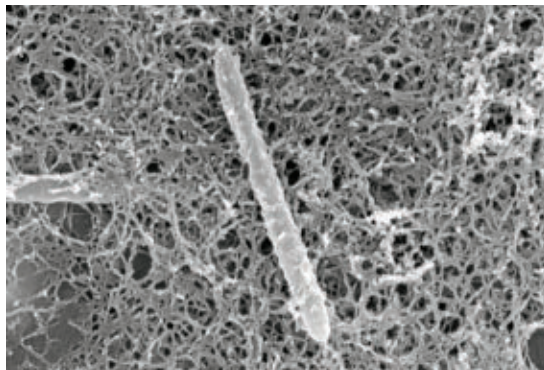
### DNA analysis reveals a self-sufficient species of bacteria

By Tina Hesman Saey

A fracture deep underground in a South African gold mine holds a rare biological find — an ecosystem populated by a single species of bacteria. An analysis of the bacterium's complete genetic makeup, published October 10 in *Science*, reveals that the species has all the tools to survive completely alone.

"This really stands one of the basic tenets of microbial ecology on its head," says Carl Pilcher, director of the NASA Astrobiology Institute at Ames Research Center in Mountain View, Calif. Scientists have thought that any microbial community would contain a variety of species, each specialized to grow on different nutrients. Some microbes would make byproducts that others could use.

Not only does the newly characterized bacterium live alone, but it also appears to live independently of the sun-powered system that helps nourish all other organisms on, or in, the Earth. (Even bacteria that get energy from chemical reactions get some nutrients indirectly from solar



***Candidatus Desulforudis audaxviator* lives all on its own, packing everything it needs into its genome.**

energy.) "This is the first pretty solid evidence that there is another source of energy life can use, and that is radioactive energy," says Pilcher, who was not part of the study team. The finding indicates that other rocky planets could support subsurface life, he says.

It takes two to three hours to descend the 2.8 kilometers to the fracture in South Africa's Mponeng gold mine where scientists discovered the community of one, says Tullis Onstott of the Indiana Princeton

Tennessee Astrobiology Initiative. Onstott, of Princeton University, was a member of the team that filtered more than 5,000 liters of water from the deep-Earth crack to collect the bacteria.

Living in an environment with a paucity of nutrients, the bacteria must rely on radiation from uranium and other minerals in surrounding rock to split water molecules. Oxygen split from water reacts with iron sulfide minerals to create iron sulfate, which the bacteria can then eat. The water in the crack is old, having last been on Earth's surface between 3 million and 10 million years ago. The water is also hot — about 60° Celsius — and under as much pressure as at the bottom of the ocean.

Researchers knew that few microbes could live in such an environment but expected to find several species. It came as a surprise when Dylan Chivian of Lawrence Berkeley National Laboratory in California and colleagues found that more than 99.9 percent of the microbial DNA came from a single species.

## Scientists make bacteria that do basic logic steps

Microbes can compute AND, OR, NAND and NOR

By Patrick Barry

If the planet Vulcan had microbes, they might look something like this: bacteria that can perform four basic operations of logic — AND, OR, NAND and NOR.

In the Oct. 17 *Science*, scientists report success in engineering such bacteria. By combining these logic units in vari-

ous ways, it could be possible to engineer microbes with an internal "decision tree" logic that controls their behaviors. The technique could give scientists a new level of control when designing microbes for a variety of uses, such as fermenting biofuels or producing pharmaceuticals.

"It's the first installation of logic gates for controlling gene expression in a living cell," comments Kensaku Sakamoto, an expert in DNA computation at RIKEN Systems and Structural Biology Center in Yokohama, Japan. "It's a wonderful result and a milestone in the efforts for artificial regulation of living systems."

Christina Smolke and Maung Nyan Win of the California Institute of Technology in Pasadena added custom-designed snip-

pets of DNA to the tail end of a gene, and then inserted that gene into either *E. coli* bacteria or cells of brewer's yeast. When cells transcribed the DNA of the genes with the snippets into RNA, the RNA snippets knotted themselves up into 3-D twists. These twists sense certain "input" molecules and respond by either cleaving the RNA strand or leaving it intact.

If the RNA is left intact, it will produce the protein it encodes; if not, it won't. It's like a binary switch in a computer.

Each twist in the RNA can be designed independently of the other twists, and combining them in various ways can make the self-destruct switch respond to different logical combinations of the input molecules.

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**T**hey're teenagers, and they're off somewhere listening to music. Fortunately for Chris Templeton, these are song sparrows, so he can put radio transmitters on them to figure out where they go.

He's guessing — remember he's working with birds — that the young song sparrows have slipped off to go to school. Or to wherever it is in the shrubbery that they find tutors and learn to sing.

Lab studies show that song sparrows, and probably half of known bird species, have to learn the species-specific songs they need for communicating in romance or war. Birdsong, Templeton says, “is a really important model system for understanding how humans learn language.” The avian descendants of dinosaurs evolved their communication independently from people. So the aspects of learning that turned out the same, as well as those that turned out different, intrigue scientists studying the brain and language.

Birds learn songs, but there's no evidence that other birds teach them — at least not in the human sense of doing something special, such as singing extra slowly in front of the chicks. Young birds do seem to listen to adults, though, and somehow end up learning a song from certain grown-ups while ignoring others.

A human might be tempted to conclude that finding the grown-up models would be easy, that a baby bird picks up the songs of its parent.

Don't bet on it, Templeton says.

To study who learns what from whom, he and colleagues at the University of Washington in Seattle have slipped into the shrubbery too. They've lugged their high-tech tracking equipment after song sparrows in the city's Discovery Park, and followed when the youngsters roamed into Seattle's streets, backyards and a military base. Templeton has been threatened with calls to the police, stonewalled by residents who don't answer doors for strangers carrying weird gear and presented with the limp body of a study subject, pried away, too late, from the family cat. “Most research on song learning has been done in the lab — and

there are good reasons for this,” Templeton says of his travails.

Yet he and other song specialists are persevering. Lab work studied the pupils. Now it's time to study the schools.

### What's to learn

Only a few animals need schooling to communicate with their own kind. Most of the trilling, roaring, squeaking and chattering out in the wild is instinctual and develops independent of teaching as animals grow up. So far biologists have found that the need to listen to experts to make intelligible sounds in the right context shows up only in certain birds, bats, primates and whales and their relatives.

Among primates, only people depend on learning for such a vital skill as producing sounds for communication. Even in birds, only some of the species learn. Plenty of parrots and hummingbirds do, and likewise many of what are called oscine songbirds, including the warblers, sparrows, blackbirds, thrushes and so on. In the past decade, some dogma-smashing research has shown that bellbirds, which don't belong in any of the established groups of bird learners, pick up vocalizations distinctive to their home regions: quacks, whistles or a noise that bird-watchers transcribe as “bonk.”

Before getting to the question of where all these young learners pick up their communication skills, Jill Soha of Ohio State University's Borror Laboratory of Bioacoustics in Columbus points out that researchers are still sorting out what learning means among birds. This fall she's writing up an experiment about what education does for grasshopper sparrows (*Ammodramus saviannarum*).

Out in the wild, a neighborhood of grown-up males sounds like a grasshopper sparrow United Nations. Each male's songs are recognizable as coming from its species: a few introductory notes and a long buzz. Each bird tweaks these elements, however, altering pitch, timing and other details into such variety that Soha can record a neighborhood's songs and find no males singing tunes similar enough to suggest a shared tutor.

Yet grasshopper sparrows do need

# Not Your Father's Song

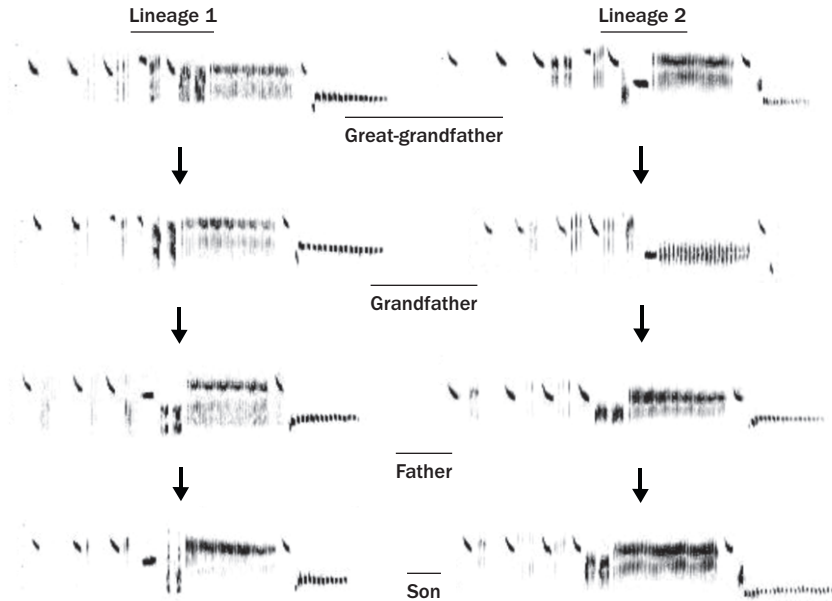
The next generation of birds chooses its music

By Susan Milius

**With each male song sparrow singing six to 12 tunes, song variety is everywhere, as shown in spectrograms of recordings.**

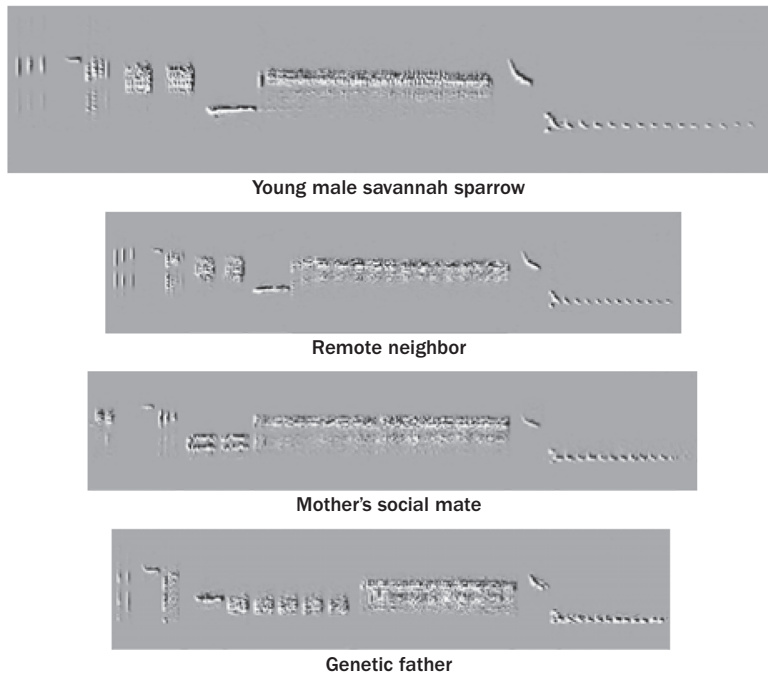
## Dad's song vs. new music

Over four generations, savannah sparrows on Canada's Kent Island in lineage 1 have learned songs (represented as spectrograms) very much like those sung by their fathers. Another family (lineage 2) on the same island has gone for more variety across generations.



## Where did he learn that stuff?

Savannah sparrow songs (shown as spectrogram derivatives) don't reveal family trees. Nathaniel Wheelwright has never found a youngster singing like his genetic dad if that dad wasn't his mother's social partner. The young male's song below sounds most like a distant neighbor's, probably learned from the same unknown tutor.



schooling of some sort. When Soha raised two youngsters in soundproof cages with no chance to hear an adult of their species, “they came up with weird songs,” she says. The birds buzzed, but sounded only marginally more like grasshopper sparrows than a kitchen appliance.

To see what learning pattern creates the diversity in adult song, Soha turned to a classic laboratory setup. She raised young birds in soundproof cages outfitted with loudspeakers broadcasting performances from different adult grasshopper sparrows.

In experiments like this in other species, such as the white-crowned sparrow, biologists in the middle of the last century came up with a basic scenario for how birds learn to sing. Before a youngster can make his own music, he needs to hear polished adult performances of his own species. (For many temperate birds, it really is *his* song. Females give short chirps and calls but don't perform the more elaborate, learned arias.)

In this established scenario, a young bird hits an impressionable age, a phase of a month or two when he memorizes what grown-up songs sound like. As he learns, he starts singing what is apparently nonsense, like a human toddler baby-talking. Gradually he enunciates more precisely. As an adult, he can produce recognizable versions of a song or songs he heard as a little fellow. Just how long a bird's impressionable phase lasts may depend on its species, with some kinds of birds picking up new songs throughout their lives.

When Soha broadcast adult song into the soundproof chambers of young grasshopper sparrows, they babbled. They slurred and lisped. Eventually they sang like grown-ups.

Their adult songs didn't follow the old rules, though. When Soha compared the students' final songs with the ones she had broadcast into their chambers, she found little resemblance. Several methods of comparing song similarity failed to agree on which student song derived from which tutor's.

So the diverse field recordings, where Soha couldn't find birds with the same tutor, meant that the species doesn't

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use tutors as tightly as previously studied sparrows do. For these grasshopper sparrows, learning may be jazz, a matter of picking up a tune and then improvising. Or, Soha says, perhaps it's closer to invention. It's certainly not learning in the sense of accurate copying.

### Our song

Even if they're only going to improvise, hatchlings have to pick the right inspiration from among all the noises of nature around them.

A bird's brain naturally seems to develop a partial template for the sound of its own species, Soha says. At least that's the idea emerging from experiments so far. This template doesn't provide the whole toolkit for developing proper songs, but it does guide a youngster in choosing what to learn.

What grabs a chick's attention and says "Learn ME" may be some signal in the song itself. For white-crowned sparrows, at least part of the cue comes from the song's opening whistle, Soha says. She has raised white-crowns to mimic ground squirrel noises by incorporating a sparrow whistle in front of rodent recordings on a tutorial tape.

An entertaining minority of birds don't stop with their own species when learning to vocalize. "When I had my first fawn-breasted bowerbird in my hand, it spewed out a series of 'recordings' as high in quality as the latest digital tape recording," says John Endler of the University of Exeter in England. The bird gave high-fidelity imitations of other local birds, horses neighing and galloping, someone saying 'morning, morning,' even someone washing dishes.

For bowerbirds, males' cross-species mimicry seems to appeal to females, but in general there's little evidence so far of any benefit for birds that copy sounds of another creature, says Joah Madden, also at Exeter. "It could be just learning gone wrong," he says.

### Parrot dialect-ics

Most birds grow up sounding like what they are — even where they are. Like people, birds can have dialects.



**Chris Templeton holds a young male song sparrow that he's equipped with a radio tag as part of a tracking project to see where juvenile birds learn their songs.**

"Wawa," says Tim Wright of New Mexico State University in Las Cruces. That's what yellow-naped Amazon parrots (*Amazona auropalliata*) from northern Costa Rica squawk among themselves as they flock together. In 1996 he described a *wawa* border across the parrots' range. South of the border, the parrots of the same species substitute *wheep*. And near the Nicaraguan border lies a third zone, where parrots call *wuleep*. Other vocalizations also change at these borders.

*Wawa*, *wheep* and *wuleep* parrot populations don't show genetic differences, Wright says. The birds probably mingle and mate, and it's learning that creates the dialect zones.

The border between the north and south hasn't moved significantly in a decade, Wright says. He has revisited old study sites, the communal roosts where the parrots gather at night, and found mostly minor changes. Parrot dialects so far appear to be a long-term feature, much like human cultural differences, he and his colleagues report in the September *Animal Behaviour*.

To see how dialects might matter in bird society, Wright's student Alejandro Salinas-Melgoza has been trying to move birds from one dialect zone into another,

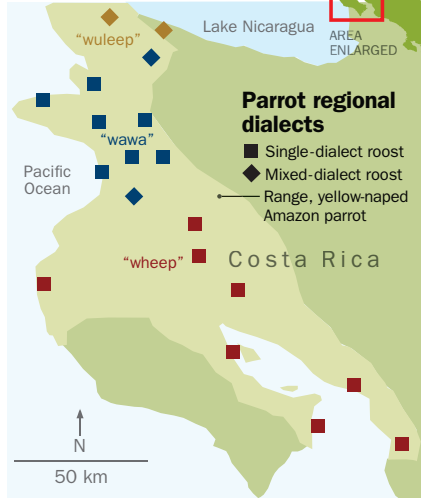
a challenging task. When he first moved adults with southern dialects some 30 kilometers into the northern zone, the birds immediately flew home.

He moved the next southern transplant farther, and a week later, brought a second bird to the same site. "Those southern birds linked right up and spent all their time together," Wright says.

Last season went better as Salinas-Melgoza worked with a young, possibly female southerner. After the move, she began hanging around with the northerners. "Within six weeks she was using the northern dialect," Wright says.

Wright had speculated that learning a new dialect arose from the need to fit in with a strange flock. Yet Salinas-Melgoza didn't see any northern parrots attacking or cold-shouldering the immigrant with the funny accent.

One bird's experience isn't definitive, but Wright now muses that maybe courtship is what drives the learning of new dialects. Yellow-naped Amazon pairs sing duets, alternating his and her parts. Wright's student Christine Dahlin has found that the parrots care about whether duets sound right, at least as far as syntax goes. When Dahlin broadcasts recordings that break common



**Yellow-naped Amazon parrots (left) learn a different contact call depending on where they live. A survey of communal roosts in Costa Rica found that the borders of three dialects—*wheep* (red), *wawa* (blue) and *wuleep* (gold)—remained stable for a decade.**

syntactical patterns, parrots ignore the loudspeakers. Maybe dialects matter too.

**Music mart**

Even within a dialect group, singers have their quirks, and youngsters can shop around for their music models.

Male savannah sparrows (*Passerculus sandwichensis*) that gather each summer to breed on Kent Island in Canada's Bay of Fundy sing the species' short, buzzy songs with a distinctive island twang. Yet among those island breeders, Nathaniel Wheelwright can recognize individual males by variations in their songs.

To see how individuals develop their own songs, he and his students at Bowdoin College in Brunswick, Maine, created a database of as many of the island song variations as they could. The team analyzed DNA samples to sort out the birds' family relations. A few songs passed from father to son with little variation for at least four generations. But for most birds, the best match indicated a neighbor as the putative tutor. Only 12 percent of males (occupying their first territory) showed a strong influence from their social father's music, the Bowdoin team and other collaborators report in the April *Animal Behaviour*. (See spectrograms on Page 24.)

Tutor choice intrigues Michael Beecher, who leads the research on song sparrows

(*Melospiza melodia*) at the University of Washington. Males grow up to sing between six and 12 distinct songs. Beecher has tested various combinations of young song sparrows and possible mentors.

In one learning test, he placed each youngster beside an adult, but allowed the young birds to hear broadcasts of other tutor-tutee exchanges. When the youngsters started singing themselves, they turned out to have learned more of their songs by eavesdropping than by copying the guy singing right in their face, Beecher and colleagues reported in 2007.

Overheard songs' allure supports Beecher's idea that a critical part of learning is eavesdropping on musical discourse in a bird neighborhood and somehow picking among the songs in play.

Now Beecher and Templeton are analyzing results from their Seattle field project tracking young birds out listening to music. The experimental demands were "insane," Beecher says. Starting in spring 2006, Templeton and his tracking team equipped young male birds with little radio tags. Thanks to the miracle of modern electronics, tags weighed only about 4 percent of the weight of a song sparrow. At that size, the batteries lasted only five or six weeks, necessitating trapping the youngster at the right time for a switch.

For a year, the crew went out every day to find young birds and record the songs

of nearby adults. On a "perfect" day, data gathering took only five hours. The real world of evasive birds, cranky bystanders and suburban cats was far from perfect.

Young song sparrows move around more than he had expected, Templeton reported at the annual meeting of the Animal Behavior Society, held in August in Snowbird, Utah. Among the 15 young males he could track, each showed up in the territories of at least 20 adult males, making for exposure to some 200 songs.

For the young, eavesdropping is easy, Beecher says. He and his students used stuffed birds of various ages to mimic feathered bystanders hanging around adult male territories. Another grown-up male, albeit stuffed, elicited protests and attacks. But residents tolerated a (stuffed) teenager without a lot of fuss, sometimes flying off to do something more urgent before the researchers had clocked a full observation session.

Young males thus get a chance to watch territorial battles and check out neighborhoods where they could soon compete for their piece of real estate. The youngsters even seem attracted to the noisy conflicts of territorial grown-ups and fly closer as if eager to catch all the details.

Listening and learning songs from a variety of future neighbors could be good preparation for the rough-and-tumble music of the adult world. Seattle's song sparrows don't migrate, and males in the sedentary population have plenty of chances to get to know their rivals.

Males face off in territorial disputes by singing to each other, and Beecher has found that repeating a rival's song back to him counts as a strong move. Learning a variety of the neighborhood songs could mean that a young male has his sassy comeback ready.

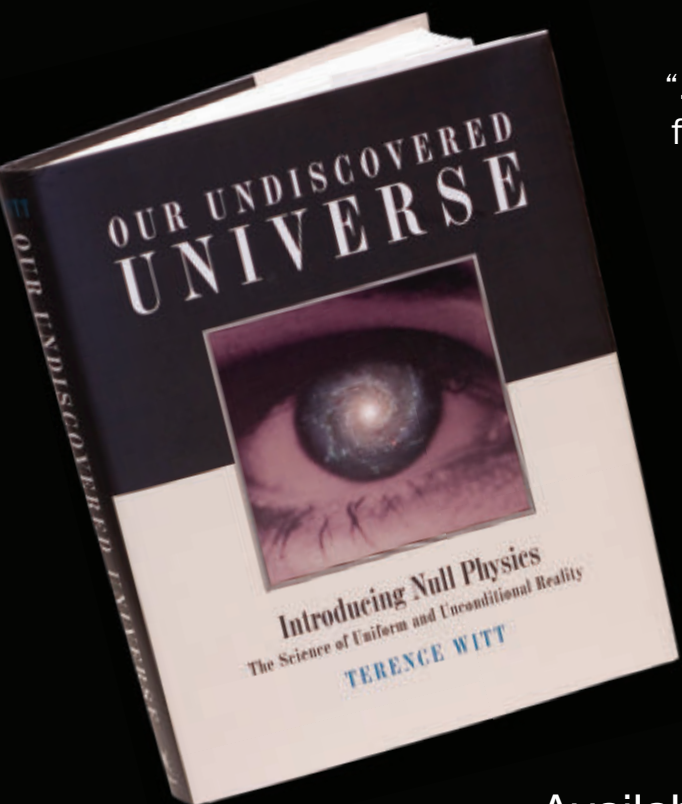
So for song sparrows that stay put year-round, choosing songs could be the first step in a world of musical warcraft. For other species, the dynamics differ, but the principle is the same: Song matters. ■

**Explore more**

- Marler, Peter and H. Slabbekoorn, Eds. *Nature's Music: The Science of Birdsong*. Academic Press. 2004.

FROM LEFT: E.R. DEGGINGER/ANIMALS ANIMALS; J. KORENBLAT; SOURCE: T. WRIGHT ET AL./ANIMAL BEHAVIOUR 2008

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## Mimicking the addictive compound's action in the brain could lead to new drugs for Alzheimer's, Parkinson's and schizophrenia

By Laura Beil

**F**irst, let's clear the air: Nicotine invites addiction, and it employs a delivery device that's been killing people for centuries. But let's also be honest: Nicotine has some attractive qualities. Smokers use it to calm jitters or perk themselves up. It's a common (if ill-advised) tool for weight control. Nicotine lowers the risk and eases the symptoms of Parkinson's disease. Patients with mental illness have high rates of tobacco use, partly because nicotine helps quiet the mind.

Because of these talents — along with nicotine's intense grip on the brain — scientists have sought compounds that can deliver the good without the harm. Now, almost 20 years after the quest began, the research has come a long way, baby. A number of experimental drugs — molecules reduced to mere shadows of nicotine — show signs of being able to exploit nicotine's power to compensate for the defects in an ailing brain.

Such drugs may offer new therapies for diseases that now have few treatment options — boosting cognition in patients with Alzheimer's disease, calming hyperactivity, relieving pain or treating mental illness. Similar drugs are also in early testing for Parkinson's disease, inflammation and even obesity.

"We're very blessed that nature gave us nicotine," says Donald deBethizy, chief executive officer of North Carolina-based Targacept Inc., which broke off from tobacco giant R.J. Reynolds in 2000. Few other compounds, deBethizy says, affect the brain at such a basic neurological level, with so much power to control chemicals that ferry signals from one brain cell to another.

Most common neurological diseases reflect problems with one of those messenger chemicals, or neurotransmitters. Drugs for such diseases usually target the activity of one neurotransmitter at a time. But nicotine is a volume knob for many at once. And that could make nicotine-mimicking drugs both potent and hazardous, affecting brain function so fundamentally as to cause worrisome side effects. In fact, the first modern drug approved that acts directly on the brain's nicotine relay system — the smoking-cessation drug varenicline — has been tarnished by anecdotal reports of nightmares and suicidal thoughts in people taking the drug. How much those problems can be blamed on the drug's action remains unclear, but it's hard to find a researcher in the field who hasn't thought long and hard about side effects.

"The issue is, as with all drugs, they

CHARLES FLOYD, SOURCE: JENSEN ET AL./JOURNAL OF MEDICINAL CHEMISTRY 2005

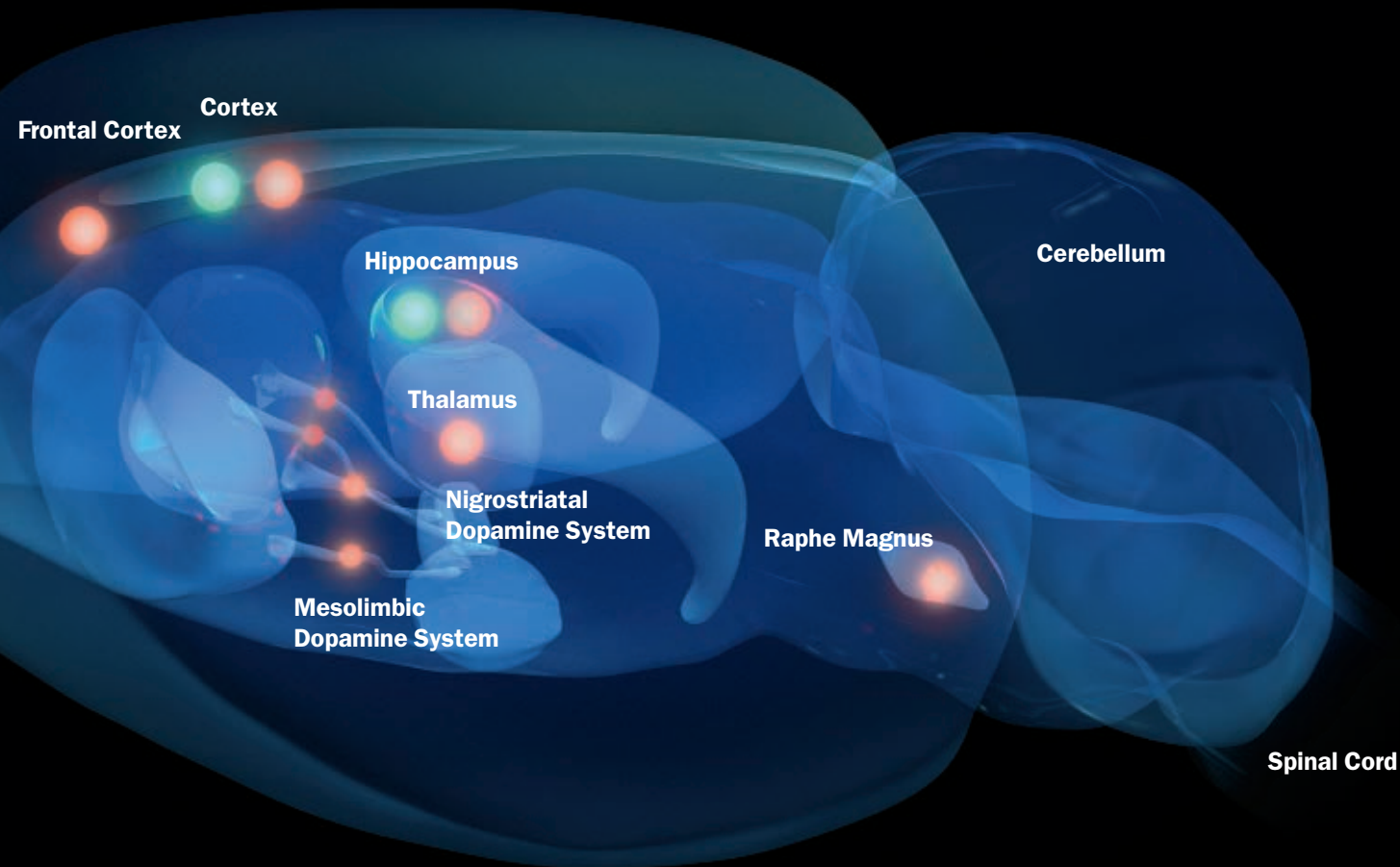
# Nicotine's

# new

# appo

## A Rat Brain Lights Up for Nicotine

Receptors that bind to nicotine are found throughout the rat brain and, presumably, the human brain. This simplified graphic shows two subtypes of these receptors in the brain areas being targeted in drug development.



Nicotine-like molecules that bind to specific nicotinic receptors in certain areas of the brain, as shown here, are being investigated as potential treatments for a number of neurological diseases and conditions.

### Receptor subtype

- alpha-4-beta-2
- alpha-7

Disease/disorder (in humans)	Receptors targeted	Key brain areas targeted
Alzheimer's	● ●	Cortex Hippocampus, Cortex
Schizophrenia	● ●	Hippocampus Hippocampus
Parkinson's	●	Nigrostriatal Dopamine System
Epilepsy	●	Frontal Cortex
Pain	● ●	Thalamus Raphe Magnus
Anxiety	● ●	Hippocampus Hippocampus
Nicotine addiction	●	Mesolimbic Dopamine System

real

have pluses and minuses,” says Allan Collins of the University of Colorado at Boulder. “Finding compounds that have more pluses than minuses has been the problem.” But, he adds, “I’m more optimistic than I have been in the past.”

**Beginning with a bad reputation**

In this case, the past dates back to the late 1980s, when researchers began to realize the breadth of the brain’s inventory of nicotinic receptors. Receptors are like docking stations, allowing molecules to attach to a cell and set a chain of events in motion. Usually each molecule lodges in a specific receptor on a cell, like a garage that houses only one make and model of vehicle. Once the molecular car is parked, a lot of running around occurs inside the cellular house. In the case of nicotine, one molecule pulls into lots of garages.

In a normal, tobacco-free existence, these receptors aren’t sitting around waiting for nicotine. They are made for acetylcholine, a powerful neurotransmitter associated in the brain with attention, learning and memory. Nicotine just happens to be a sometime impostor for acetylcholine in smokers. “Nicotine is a

sloppy drug that acts at all these receptors,” says Martin Sarter of the University of Michigan in Ann Arbor. Also, nicotinic receptors adapt to chronic exposure over time. The changes differ depending on the type of receptor and where it lies in the brain. Such changes are thought to explain why smokers lose sensitivity to nicotine, eventually requiring higher doses to achieve the same effect.

As they identified more and more receptor subtypes, scientists began to wonder how the brain would respond to a nicotine-like molecule that could activate just one type of acetylcholine receptor. For 15 years or so, not many people cared to know. Aside from isolated academic exploration at universities, the vast majority of commercial drug pursuit came from the R.J. Reynolds team that would become Targacept, as well as the Illinois-based firm Abbott Laboratories. It seemed that nicotinic receptors’ pedigree presented a public relations headache. Even if the research could produce great new drugs for desperate needs — consider the prediction that more than 8 million North Americans will develop Alzheimer’s by 2050 — pharmaceutical executives

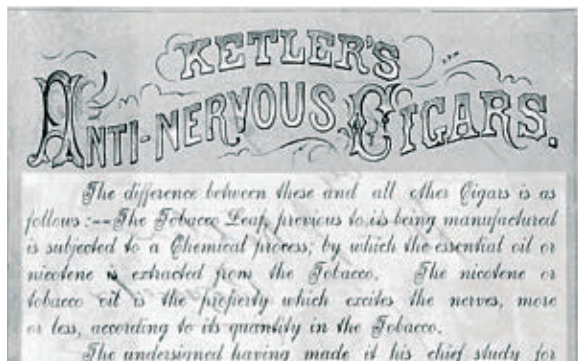
feared that nicotinic drugs would have a questionable image. (Indeed, the corporate public affairs office at Abbott said the company would not contribute to this story.)

“It was very difficult in the beginning,” says Stephen Arneric, who worked on nicotinic drugs at Abbott during the 1990s, but has since joined the biotech startup Neuromed. “When the program was started at Abbott, the first question out of senior management was, ‘Merck isn’t doing it, why should we?’” Arneric and his colleagues even launched a quiet, so far unsuccessful, campaign to change the name of the receptors, removing the regrettable name “nicotinic” to make the research more palatable.

“The demonization of nicotine is what we’re all up against,” deBethizy says. However, unlike the lonely years of the 1990s, it’s now difficult to find a major drug company not trying to capitalize on nicotinic receptors.

**Receptor by receptor**

Chemists have produced molecules with selectivity for only one particu-



<b>Before 1492</b> Native Americans smoke tobacco, some in sacred rituals	<b>1492</b> Columbus writes of tobacco use in his diary	<b>1867</b> Nicotine touted as what “excites the nerves” in tobacco	<b>1875</b> R.J. Reynolds Tobacco Company established	<b>1930s</b> Tobacco use promoted as a healthful practice	<b>1940s</b> Smoking rates soar during World War II	<b>1964</b> U.S. Surgeon General puts out influential report on serious health risks of smoking
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**Nicotine for what ails you**

**Part of tobacco’s danger lies in its addictive quality, mediated by nicotine. But nicotine also boosts memory, among other beneficial effects. The search is on for molecules that act like nicotine but carry none of tobacco’s negative health effects.**



lar receptor type at a time. The biggest players remain Abbott and Targacept. Generally, drugs in development target two particular subtypes of nicotinic receptors, known in shorthand as alpha-4-beta-2 and alpha-7. Other types of nicotinic receptors are scattered throughout the brain, in muscle and in cardiac tissue. But in the brain these two appear to be common and best suited for disease treatment. Farthest along in testing are drugs for Alzheimer's disease, depression, pain and attention-deficit/hyperactivity disorder, or ADHD.

In 2006, Targacept researchers released the results of a study of a nicotine-like drug designed to improve cognition in people with Alzheimer's disease. The drug is designed to bind only to the alpha-4-beta-2 receptors in the brain and boost other neurotransmitters. In collaboration with AstraZeneca Pharmaceuticals, the company completed a randomized trial involving 193 patients with memory impairment (though not dementia) related to Alzheimer's or schizophrenia. After taking the drug for 16 weeks, patients

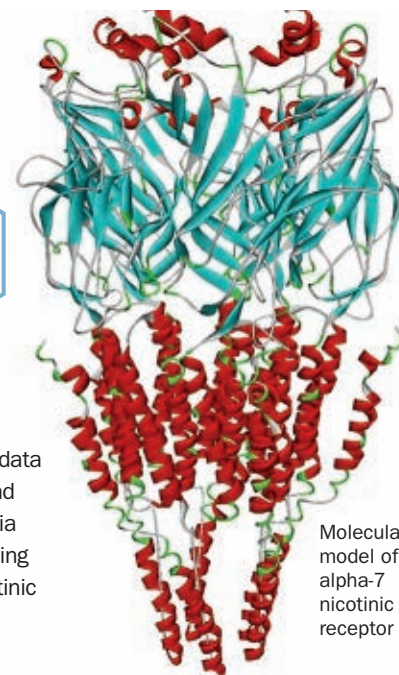
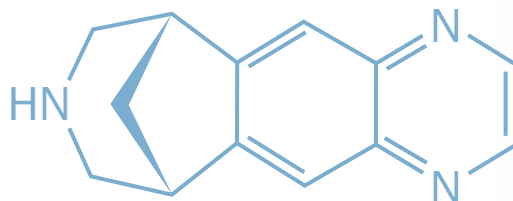
showed improvements on tests of attention and memory, the researchers reported during an Alzheimer's research meeting the same year. But in September, the company issued a press release calling results of a larger study "inconclusive."

A separate Targacept drug, this one for depression, is also working its way through the testing process. In 2007, at a meeting of the British Association for Psychopharmacology, the company described a trial involving 184 volunteers who had not responded well to first-line antidepressant drugs. The results of this study were encouraging enough to expand trials, though the true effectiveness of the drug—as with all nicotinic compounds—won't be known until further studies are completed.

Also, a partnership of two companies, Abbott and the Denmark-based NeuroSearch, announced this year the results of tests on a drug for ADHD. That study, described in May during the annual meeting of the American Psychiatric Association, involved 221 adults with ADHD. After taking the drug for four weeks, volunteers reported an increase

in work productivity and a reduction in absenteeism. Based on these results, the companies plan to move the drug into further testing. In a twist that speaks to the broad influence of nicotinic receptors in the brain, the same drug also appears to be a candidate for pain control.

Not all testing falls under the domain of pharmaceutical corporations. In August, a research team led by scientists from the University of Colorado Denver published the results of a study testing a nicotinic compound for schizophrenia, a disease that has been the subject of a decades-long search for new treatments. Upwards of 85 percent of people with schizophrenia smoke, largely because many patients feel a greater mental clarity when they light up. Writing in the August *American Journal of Psychiatry*, the research team described the results of tests in 31 people who received two different doses of the experimental medication. The molecule targets the alpha-7 receptors in the brain. The results were heartening, though not dramatic, and the usefulness of the drug is still unknown.



Molecular model of alpha-7 nicotinic receptor

**1988**

C. Everett Koop publishes his U.S. Surgeon General report declaring nicotine as addictive as heroin

**1980s**

Isolation of nicotinic receptor subtypes in mammalian brains and nervous systems

**1990s**

Abbott Labs begins work on drugs that target nicotinic receptors in the brain

**2006**

Smoking-cessation drug Chantix (shown) becomes first FDA-approved medicine that targets receptor subtype

**2008**

Release of clinical trial data for ADHD and schizophrenia drugs targeting human nicotinic receptors

FROM LEFT: W.J. KETTLER/LIBRARY OF CONGRESS (LOC); R.J. REYNOLDS TOBACCO COMPANY; COURTESY OF THOMAS A. GRAY; OFFICIAL PHOTO, U.S. AIR FORCE/LOC; VINCE MANNING/CORBIS; J. KORENBLAT; JERREL YAKEL/NATIONAL INSTITUTE OF ENVIRONMENTAL HEALTH SCIENCES

## Strong medicine

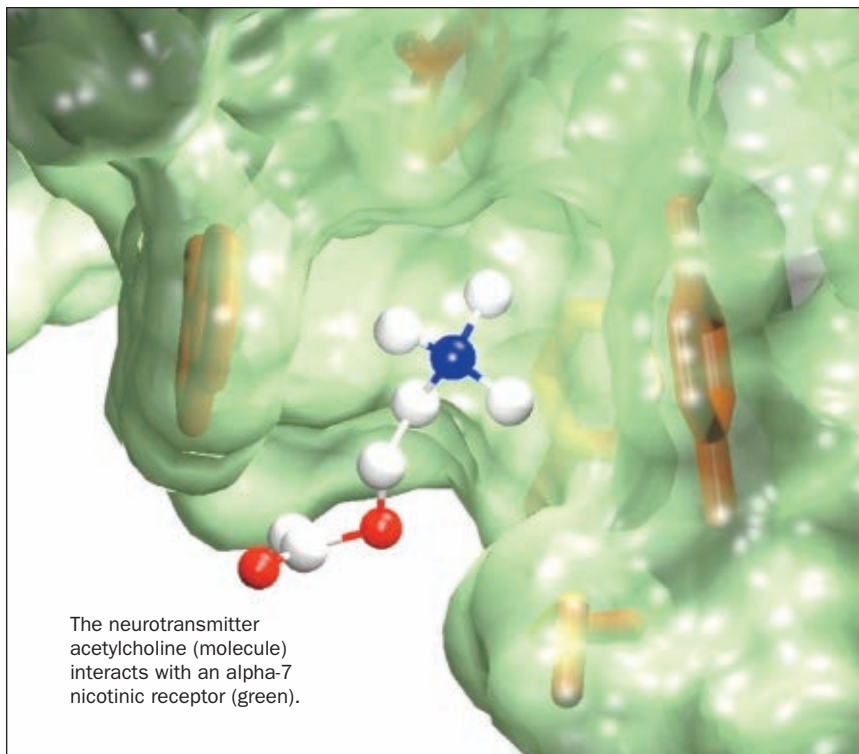
In most of these early drug trials, complaints have been similar to those felt by many a teenager sneaking his first cigarette — nausea, diarrhea, dizziness. Nonetheless, side effects are still among the biggest concerns. Everyone in the field took note in February when the U.S. Food and Drug Administration hastily called a news conference to announce a public health advisory for varenicline, the anti-smoking drug made by Pfizer under the trade name Chantix. The FDA warned of mood changes, suicidal thoughts and suicide. “Clearly these are very concerning findings for this product which is being widely used,” the FDA’s Bob Rappaport told reporters.

Until these reports began to surface, the approval of Chantix had been a bellwether in the race for nicotinic drugs: a medicine that had entered the market and shown record success. Smokers taking Chantix have a much better track record of giving up cigarettes than those trying other methods. Animal studies suggest the drug might one day have a role in treating alcohol addiction. The side effects remain unexplained.

“They may indicate the heterogeneity of the human brain and the condition,” says Roger Papke of the University of Florida in Gainesville, who has long studied nicotinic receptors. As with other illnesses, each person may have variations in receptors that alter his or her response to the drug.

Varenicline binds to nicotinic receptors, interfering with the mechanism most strongly associated with addiction, with the idea of still allowing the brain enough reward to ease withdrawal symptoms. Whether the molecule in its current form binds too many types of acetylcholine receptors, whether it activates other neurological systems or whether suicide risk is simply elevated among people giving up cigarettes is unknown.

“I don’t think they’re going to see it in all drugs,” Arneric, the former Abbott scientist, says about these types of side effects. “If you look at nicotine itself, it doesn’t have those side effects.”



The neurotransmitter acetylcholine (molecule) interacts with an alpha-7 nicotinic receptor (green).

**A native neurotransmitter binds to a nicotinic receptor on a neuron. Nicotine and a number of new drugs for a variety of diseases hit the same brain receptors.**

## An extra dose

Developers of nicotinic drugs have had to make one other consideration: 20 percent of the adult U.S. population smokes, and will administer their own nicotine on top of whatever drug they may receive for an illness. In doing so, they will be stimulating nicotinic receptors in the blunt, old-fashioned way along with a treatment for memory or pain. No one can say with certainty what that means.

Then there’s the property of nicotine everyone knows — addiction. Can a medicine that works like nicotine, even if it isn’t really nicotine, completely rid itself of nicotine’s most notorious quality? “The exact basis for the addiction to smoking — that is more complicated than it seems,” says University of Michigan’s Sarter. “Is it possible that these selective compounds produce an addictive component? I don’t think we know at this point. Personally, I don’t think this is the case.”

DeBethizy of Targacept — who spent years as an R.J. Reynolds scientist — believes that addiction to nicotine

has much to do with binding to another type of receptor, alpha-6. “We’ve decided that the best way to make nicotinic drugs is to develop selective compounds,” he says. “Steer away from a form of alpha-6, which is involved in addiction.” Though it’s still too early to draw conclusions, he says that so far the nicotinic drugs haven’t shown signs of causing cravings or dependence.

Which means, for the first time in human history, drugs may come along that have a nicotine-like relationship with the brain in a way that has nothing to do with addiction. “There will be some good new medicines,” Arneric predicts. If that’s true, a drug that has been an accomplice in millions of deaths may finally have a chance to help make some lives better. ■

*Laura Beil is a freelance science writer based in Texas.*

## Explore more

■ More information on the brain and its receptors: [thebrain.mcgill.ca](http://thebrain.mcgill.ca)

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# Long Live Plastics

With plastics in museums decomposing, a new effort seeks to halt the demise of materials commonly thought to be unalterable **By Sid Perkins**

**B**ecause plastic products can be mass-produced cheaply, they have long been considered the poster child of a throw-away culture. Plastics are versatile: Some are soft and flexible, but others are completely rigid. A few mimic natural substances; some are infused with colors rarely found in nature. Others are as clear as glass. And some polymer substances composing plastics can be molded into shapes impossible to reproduce with materials such as wood.

Perhaps because they are so versatile, some objects made from plastics have become highly collectible. Some museum collections, in fact, specialize in items commonly made of plastic — toys, games and dolls, for example. Other museums couldn't avoid the polymers if they tried: Plastics show up in everything from fabrics to furniture, sequins to sculpture.

Though often praised for their chemical stability, plastics don't last forever. Vinyl can crack, polyurethane can get cloudy and flexible tubing can become



stiff. Even Ken and Barbie, like anyone approaching 50, can succumb to blemishes, age spots and loss of skin tone.

A decade ago, a survey of museum collections in London confirmed the ephemeral nature of polymers: About one out of every eight plastic items showed signs of physical degradation such as cracking, discoloration or deformation, says Bertrand Lavédrine, an analytical chemist at the National Museum of Natural History in Paris. That doesn't mean the other plastic objects will stay in good shape. Even items that appear fine for long periods can suddenly deteriorate once chemical changes start, he notes.

Most chemical changes triggering polymer degradation are irreversible.

**The series of images at left shows the stages of degradation of Antoine Pevsner's 1923 "Head of a Woman," made of nitrocellulose plastic. At right, wax used as a molding release has migrated past the polyvinyl chloride skin of this 1960s doll, leaving a blotchy white coating.**



But given the right conditions, the demise of plastics can be slowed. Often, however, the challenge is to find those conditions.

“The museum world, in particular, has suffered badly from a lack of detailed understanding about the materials and techniques used for the manufacturing, the conservation and the restoration of artifacts that are now in critical condition,” says Lavédrine.

Hence the need for the POPART project. This 42-month, multimillion-dollar program — whose name is a shortened version of “Preservation of Plastic ARTefacts in museum collections” — was launched in October to address many of the problems that curators now face. Funded by the European Commission, researchers from the dozen participating museums, government agencies and universities in eight countries will survey museum collections, study how certain polymers deteriorate, develop techniques to display and clean plastic items and design equipment that can quickly discriminate one type of plastic from another.

**Chain, chain, chain**

Plastics are a type of polymer, a class of materials that gets its name from the Greek words for “many parts.” Researchers create polymers by chemically stringing together large numbers of simple carbon-based units called monomers (“single parts”). The near-endless variety of plastics stems from the diversity of monomers — esters, amides and imides, to name a few — and the degree of linkage that exists between polymer chains: In general, the more bonds there are, the stiffer the plastic.

Materials scientists can use a variety of additives to further tailor a plastic’s physical properties, says Brenda Keneghan, a polymer scientist at the Victoria and Albert Museum in London. Plasticizers such as phthalates, phosphates and glycerols add flexibility and make the plastic workable, she explained in July at the Euroscience Open Forum in Barcelona. Lead and other metallic substances can chemically stabilize the material. Other additives, including pigments and flame retardants, slow degradation that results

from exposure to heat, light and atmospheric oxygen.

The problem, says Keneghan, is that many of these components aren’t chemically bound to the polymer chains. Thus, over time and under certain conditions, the additives can ooze out of the plastic. Studies suggest that many of these substances — including phthalates (*SN*: 6/4/05, p. 355), flame retardants (*SN*: 3/26/05, p. 206) and bisphenol A (*SN*: 9/13/08, p. 15) — leach from consumer products and can cause significant health problems for humans.

Loss of these additives doesn’t help



**Early items first made of cellulose nitrate, now a common plastic, were marketed as luxurious because they resembled tortoiseshell and ivory. As the plastic naturally breaks down, it releases nitric acid. The acid corroded the lead motif on the comb below. The sunglasses above remained inside their case, but the plastic still broke down and the nitric acid did its own damage.**



the plastic either. When liquids leach from the material, surfaces can become covered with bloom — the same sort of powdery coating that forms on chocolate when sugar and fat migrate to the surface after the chocolate is stored in cool or wet conditions, says Keneghan. If the oozing liquids are oily or sticky, they attract dirt that often can’t be easily removed.

Such physical changes in plastic materials are just the beginning. Any number of factors — including exposure to ultraviolet light, ozone or even atmospheric oxygen — can trigger chemical changes that can cause the plastic to crack or become discolored. Vinyl car roofs, a popular option on automobiles in the 1970s, are a good example, says R. Scott Williams, an analytical chemist at the Canadian Conservation Institute in Ottawa. The roofs “looked fine for a while after they were purchased, and then they suddenly degraded” when chemical reactions accelerated by long-term exposure to sunshine and pollutants consumed the vinyl’s stabilizers and antioxidants.

There is no standard way to preserve damaged plastic items. Any attempt to ameliorate their deterioration often causes more problems than doing nothing, says Keneghan. At present, she notes, the most effective interventions are preventive — displaying at-risk items in a cool, low-light environment with stable humidity, for example. Other tricks include using materials such as activated charcoal and other absorbent materials to scavenge oxygen or acidic fumes from the atmosphere surrounding the objects.

In the POPART project, researchers will explore ways to conserve plastics. One possibility, says Lavédrine, might be to use gamma rays to repolymerize the material in fragile plastics such as polyurethane foam, often used in furniture cushions or to pad museum drawers. The same technique could be used to form a protective veneer on some types of plastics. Scientists also will evaluate various solutions and cleaning techniques to see how well they clean an object without causing long-term damage.

## Hiding in plain sight

Soon after Graham Martin, an analytical chemist who is now head of science at the Victoria and Albert Museum, arrived at the V&A in the early 1980s, he asked curators to inventory the plastic items in their collections. "They all said that they had none, and they were all wrong," he says. "Today curators are much more aware of polymers, but then again there was a lot of room for improvement."

As the United Kingdom's national museum of art and design, the V&A contains many items composed of at least some plastic parts. While some plastics are obvious, others turn up in unexpected places, says Keneghan. A partial survey of the museum's holdings recently found more than a thousand polymer-containing objects in the metalwork collection — many of them plastic baubles in jewelry — and dozens of items with plastic components in the furniture and woodwork collection. Unsurprisingly, the curators tallied more than 6,000 plastic artifacts related to childhood, including dolls, toys and games. In the fashion collection, which wasn't part of the recent inventory, plastic items include everything from vinyl boots and accessories to fabrics, jewelry and sequins, she told the audience in Barcelona.

Of nearly 8,000 items identified by the inventory, researchers deemed 15 percent to be in poor or unacceptable condition. Another 13 percent of the objects showed signs of chemical changes; more than half of those had become brittle, and one-fifth of the items were discolored.

One of the first tasks of the POPART project will be to conduct similar inventories of other national collections in Europe, says Lavédrine. By assessing the frequency and type of degradation among a wider sampling of museums, the project's scientists can better tailor research priorities for later phases of the effort.

Determining the current condition of an object, plastic or not, is critical to figuring out how to preserve it, says Keneghan. Perhaps more important, researchers also need to know what type of plastic the object is made of. For 94 percent of the objects surveyed

in the Victoria and Albert collections, the identity of the plastic — and therefore how the material might degrade — is unknown. More than half of the rest are known to be made of an unstable material, she says.

Pinning down a plastic's identity typically involves sending a piece back to a lab for analysis, but museum curators often are loath to mar an artifact to gain even a small sample. Nondestructive methods such as infrared spectroscopy — shining low-level light on an object and then scrutinizing the intensities and wavelengths of the light that bounces back to a detector — is a promising technique, says Williams, who is trying to develop and refine such equipment.

Using a portable unit and a database of reflectance spectra that are signatures of various plastics, researchers could swoop into a museum and efficiently identify the composition of hundreds of artifacts in the course of an afternoon, he says.

POPART aims to develop other nondestructive analytical techniques for identifying plastics, says Lavédrine. Researchers will also work to enhance current analytical methods, such as gas chromatography and mass spectrometry, making them quicker, more accurate and able to take smaller samples.

## Incomplete census

Even an accurate tally of a museum's artifacts wouldn't include all of its polymers. Drawers and storage boxes can be lined with foam cushions, and the tubing that circulates air through display cases sometimes is made of plastic, as are parts of the display cases themselves. Photographic slides and negatives often are stored in plastic sleeves. Degradation of these auxiliary materials can damage a museum artifact as surely as deterioration of the item itself.

Williams has long crusaded against the use of flexible polyvinyl chloride tubing to circulate air through exhibits. As much as 40 percent of the material by weight can be plasticizers, not polymer. Even slight changes in humidity can affect the material's stability, driving the oily additives out where they damage

nearby objects. The tubes also can emit vapors such as hydrogen chloride, which when dissolved in water droplets creates hydrochloric acid.

As they degrade, many polymers give off corrosive byproducts — which has led chemists to dub them "malignant" plastics. One of the most prevalent is cellulose acetate, a material used in jewelry to simulate natural materials such as tortoiseshell, ivory and mother-of-pearl but most commonly used as photographic film. When cellulose acetate deteriorates, it gives off acetic acid — the ingredient that gives vinegar its pungent odor and taste. Not only does the acetic acid eat away at the surface of the object that's deteriorating, its vapors can chew away at any artifacts nearby. "When you open up a box and smell vinegar, you know your items are in trouble," says Keneghan.

POPART scientists will study the degradation of cellulose nitrate — a forerunner of cellulose acetate that gives off nitric acid as it deteriorates — and of polyurethane, says Lavédrine. Researchers will look to identify chemical markers for polyurethane degradation and measure how variations in humidity, temperature and atmospheric oxygen affect the material's rate of deterioration.

The POPART project is all about preserving cultural heritage, says Martin. "One of the big questions is, 'How can we keep what we have longer?'" he says. "A lot of the damage we see might be difficult to reverse, but it still needs to be assessed."

Challenges in preserving plastics will not be small, and figuring out how to preserve one type of plastic won't necessarily solve all a curator's problems. "I've always been jealous of film archivists," Martin notes. "They only have to deal with one type of plastic, and we've got a multitude of them.... A plastic chair might have a nylon cover over a polyurethane foam cushion over a polypropylene base," he bemoans. "That's three plastics right there in just one item." ■

## Explore more

■ The POPART project: [popart.mnhn.fr](http://popart.mnhn.fr)

**Poisoned Profits: The Toxic Assault on Our Children**

Philip Shabecoff and Alice Shabecoff

In this powerful investigative work, the Shabecoffs tell the stories of communities from Dickson, Tenn., to Pittsfield, Mass., where chemicals have seeped into water, air and bodies — debilitating children and leaving parents searching for answers.

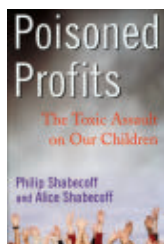
The authors capture community efforts to connect clusters of disease to chemicals — including TCE, phthalates, chromium 5 and Teflon — and illuminate the underlying policy reasons for gaps in governmental oversight.

Written in highly readable prose, the book critically examines why some of these chemicals have not been regulated in America and enumerates cases where companies settled with affected families out of court, paying off the families in exchange for “no fault” clauses.

Beyond identifying these important issues in consultation with experts,

the Shabecoffs provide concrete safety tips on topics including purifying water, avoiding toxins in cars, keeping chemicals out of the home and buying safer plastics.

More than a hundred interviews with corporate researchers, public health leaders, government insiders and affected families support this cautionary tale of collusion



that falls short of being alarmist. The authors ask readers to demand accountability and public health scrutiny for the benefit of future generations.

“We focused on children because people care about children, but they are only our canary in the coal mine,” Philip Shabecoff said at a September book talk in Washington, D.C. “We are all at risk.”

— *Dina Fine Maron*  
Random House, 2008, 353 p., \$26.

**Sun in a Bottle: The Strange History of Fusion and the Science of Wishful Thinking**

Charles Seife

Fusion is the source of energy that’s 30 years away, and always will be, skeptics quip.

In principle, the energy released when light atomic nuclei are fused to form heavier ones is much greater than the energy required to coax the light nuclei into fusing in the first place.



That’s how the sun has been shining for billions of years. And ever since the first hydrogen bomb tests in the 1950s, scientists have hoped to reproduce the sun’s magic in a controlled fashion, unlocking an unlimited source of energy. But the dream has been elusive.

With great explanatory skill, Seife, a journalism professor at New York University, explains how fusion works and

why it is so hard to get power out of it. Seife reviews the parade of hubristic and sometimes comic or outright dishonest claims that fusion scientists have made over the decades.

Edward Teller proposed using hydrogen bombs to widen the Suez Canal, and Martin Fleischmann and Stanley Pons reported producing a tabletop nuclear fusion reaction at normal temperatures and pressures — “cold fusion.”

But there are also lesser-known episodes. In 1951, for example, Argentine President Juan Perón pompously announced that his country had learned to control fusion with a secret material, which scientists suggested was probably baloney.

Although Seife sometimes goes in circles and makes the same point multiple times, the book — his fourth — is enjoyable, and a must-read for anyone who wants to know the story behind ongoing multibillion-dollar attempts at bottling up the sun. — *Daide Castelvocchi*  
Viking, 2008, 294 p., \$25.95.



**Global Catastrophes and Trends: The Next Fifty Years**

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A tempered and practical look at the trends driving change in the 21st century. MIT Press, 2008, 307 p., \$29.95.



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An argument that magnetic resonance imaging does not deliver on all its health promises. Cornell Univ. Press, 2008, 198 p., \$21.95.



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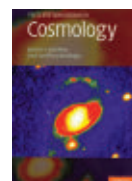
Advice for kids about those scientific curiosities that they shouldn’t explore — at least not with their hands. Chicago Review Press, 2008, 108 p., \$9.95.



**Neuroengineering the Future: Virtual Minds and the Creation of Immortality**

Bruce F. Katz

A description of the science that could transfer a mind to a machine. Infinity Science Press, 2008, 389 p., \$49.95.



**Facts and Speculations in Cosmology**

Jayant V. Narlikar and Geoffrey Burbidge

Physicists argue that the universe’s mysteries are far from being solved. Cambridge Univ. Press, 2008, 287 p., \$60.

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**Testosterone proxy**

In the study on the correlation of high levels of serum calcium with fatal prostate cancer (“Cancer-calcium connection,” *SN*: 9/27/08, p. 12), were testosterone and vitamin D levels also measured simultaneously? Since low levels of both are related to osteoporosis in men, and testosterone is known to be a fuel of cancer, wasn’t perhaps calcium just a proxy for testosterone?

**Edward Kausel**, Cambridge, Mass.

*Participants were given vitamin D and calcium supplements as part of the study. But the researchers didn’t measure blood levels of vitamin D, and they acknowledge that these levels vary considerably among individuals and might influence cancer risk. The researchers also didn’t measure testosterone levels. The potential confounders the team accounted for were age, body mass, race and family history of prostate cancer. — Nathan Seppa*

**Biologists gone bad**

The mercenary pattern identified by David Michaels (“Corporate campaigns manufacture scientific doubt,” *SN*: 9/27/08, p. 32) is one reason it has been difficult to fight developers who destroy habitat in southern California. They hire accredited biologists who can stand next to an endangered plant and not see it, or do surveys for reptiles in February, nesting birds in October or seasonal migrants in the wrong season. Thus the endangered species that use the habitat are reported not to be there, and the development goes ahead. We call such scientists “biostitutes.”

**Drew Feldmann**, San Bernardino, Calif.

**Following the yawn**

The article “Man yawns, best friend follows” (*SN*: 8/30/08, p. 13) concluded that, “If the study can be replicated, it strongly suggests that dogs may have a primitive empathy capacity.” I like dogs, but before I can jump on the empathetic-canine bandwagon, I need to know if the researchers were aware of and controlled for the following: Dogs

(along with many other animals) aren’t comfortable while being stared at, and they aren’t comfortable in the presence of unusual behavior. Dogs, when uncomfortable, often “yawn” to relieve stress. Did these canines show empathy? Or, did they merely show what dog trainers refer to as “stress yawning”?

**Gretchen Dean**, Minneapolis, Minn.

*If stress were the main factor, then the dogs would probably have yawned during a modified version of the test, in which the person caught the dog’s eye and then silently made a face, but didn’t yawn. When the researcher only made a face, the dogs didn’t yawn. — Susan Milius*

**A global food disaster**

Sid Perkins reminds us in “Disaster Goes Global” (*SN*: 8/30/08, p. 16) that in some regions we humans are already consuming close to two-thirds of the land’s biomass. A couple of years ago, a study warned us that at current fishing rates we’ll deplete the ocean’s seafood stocks by 2050 (“Worthless waters,” *SN*: 11/4/06, p. 291). Yet unless we make efforts to slow the growth of the world population, our numbers will increase by 40 percent in that same time frame. Is my math wrong, or are we going to run out of food?

**Patricia Leitner**, Oakland, Calif.

**Multistep reactions**

According to “Disaster Goes Global” (*SN*: 8/30/08, p. 16), sulfur dioxide reacts with water vapor in the air to produce sulfuric acid. Is this possible? When sulfur dioxide dissolves in water, it produces sulfurous acid, not sulfuric. Industrial production of sulfuric acid requires that sulfur dioxide be further oxidized to give sulfur trioxide, which produces sulfuric acid when dissolved in water.

**John Myers**, San Diego, Calif.

*The sulfuric acid in volcanic aerosols is the result of not one reaction but a series of reactions involving sulfur dioxide (from the volcano), oxygen (from*

*the atmosphere) and water (from both sources). One of those pathways, as you mention, first creates sulfurous acid that then reacts with oxygen to make sulfuric acid. In the other set of reactions, sulfur dioxide reacts with oxygen to make sulfur trioxide, which then reacts with water to create sulfuric acid. — Sid Perkins*

**Correction:** The article “Path to math” (*SN*: 9/27/08, p. 10) incorrectly stated that participants in the experiments viewed arrays of dots containing five to 16 dots. What it should have said was that participants viewed arrays of dots containing five to 16 blue dots and five to 16 yellow dots.

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## It's time for addiction science to supersede stigma

**W**e have a well-honed ability for branding the undesirable attributes of “others.” This natural human tendency has evolved and persists for a reason: The definition of an outcast group helps society to delineate its “normal” boundaries. But this inclination can also breed counterproductive stigmas that are rooted in ignorance and that too often translate into staggering individual, social and economic costs. This makes the need to understand and confront these types of stigmas much more than a purely academic goal.

Sociologists like Gerhard Falk are quick to distinguish between “existential” stigmas (spurred by conditions like mental illness, over which the target has little or no control) and “achieved” stigmas (perceived as earned by the subject’s own actions, like criminal behaviors). At first blush, this tidy classification appears to provide a satisfying framework for deciding the ethical, moral and even legal standing of stigmas. But sometimes it fails — for instance, when deciding how to assign drug abusing or addicted individuals to either category. Clearly, while substance-use disorders are themselves recognized psychiatric conditions, their trajectories begin with seemingly voluntary action, often tinged with criminal — or at least deviant — overtones. In other words, the stigma associated with these disorders displays both existential and achieved qualities, a thorny state of affairs that poses unique challenges for public health stakeholders and policymakers.

Fortunately, it is possible to sidestep what would otherwise be a paralyzing social stigma and leverage substantial resources for the good of all. For example, as biomedical advances prodded society to recognize that AIDS was preventable and treatable, attitudes toward the disease and its victims evolved. As a result, the stigma associated with HIV

status may not have been eliminated, but it is no longer the roadblock to effective health policy that it once was. This lesson should serve us well as we refine our stance vis-à-vis drug abuse and addiction, where multiple lines of research support an approach based on science, not on stigma.

First, we have gathered incontrovertible evidence showing that addiction is a disease of the brain. Most drugs of abuse exert their initial reinforcing effects by inducing dopamine surges in the brain’s reward centers. If they persist, such disturbances eventually disrupt other circuits, many of which are critical to a person’s self-control. Second, we now know that abuse and addiction do not occur in a vacuum. A smart approach to managing these disorders must consider contributions from a bewildering array of predisposing or complicating factors, such as poverty, urban decay, child abuse and neglect, chronic stress, comorbid disease, and genetic background. Third, cost-effective and efficacious treatments are available that can be adapted to many community settings. Research shows, for example, that the integration of drug abuse treatment into the criminal justice system facilitates an individual’s successful reentry into society, with positive impacts on public health and safety.

These and other developments are the products of a new generation of interdisciplinary scientists who have transformed our understanding of psychiatric disorders like addiction. The message is unmistakable: Whether addiction stigma is existential or achieved or somewhere

in between, it is time to replace outdated and failed thinking with approaches that work. The evidence demands that we:

- Develop and support naturally reinforcing alternatives to shield youth from dangerous forms of experimentation.
- Educate and engage the medical community so it can detect and address substance-use disorders early and act appropriately.

- Encourage and reward partnerships with the pharmaceutical industry to dramatically enhance the R&D success rate of addiction medications.

- Open up and broaden affordable access to available addiction treatments for every population that needs them, in a manner that guarantees privacy and that does not affect insurability.

This agenda is admittedly lofty, but the scientific method, which has been successful at shattering prejudices and enlightening societies, is on our side. If we can translate the fruits of research into policies that work, building public confidence in the science of

addiction treatment, we will be well on our way to making the addiction stigma a relic of the past.

We are at a historical crossroads. We can continue playing the blame game, piling up unimaginable health and economic costs. Or, we can parlay the transformative power of scientific discovery into a brighter future for addicted individuals, for their families and for society at large. Let us choose wisely. ■



**We can continue playing the blame game. Or, we can parlay the transformative power of scientific discovery into a brighter future for addicted individuals.**

*Nora Volkow is the director of the National Institute on Drug Abuse.*



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