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ScienceNews

MAGAZINE OF THE SOCIETY FOR SCIENCE & THE PUBLIC ■ SEPTEMBER 10, 2011

Brain Slams Brakes Faster

Antidepressants vs. Alzheimer's

Weight-loss Surgery and Diabetes

Battle for the Bats

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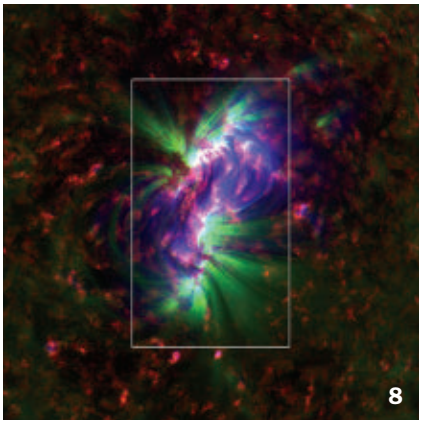

ScienceNews

In The News

Features

Departments

COVER White spots on this hibernating bat indicate it has been hit by a lethal fungus that is severely depleting North American populations. *R. von Linden/N.Y. State Dept. of Env. Conserv.*

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FROM THE EDITOR

Computers on your skin illustrate science's skills

Fake tattoos once implied a commitment to lack of commitment. Someday they may suggest commitment to a marriage of electronics and biology.

Few people who survived the 20th century aren't familiar with the concept, typically illustrated by the fictional man-machine amalgamation known as a cyborg. You know — the Six Million Dollar Man, the Terminator, or Jean-Luc Picard when captured by the Borg (who collectively objected to the *cy-* prefix). Integrating electronic computer technology into the human body has long been a dream of science fiction writers, surgeons and spies.

In this issue (Page 10), Laura Sanders describes the latest technological advance toward the cyborgian future: stretchable electronic adhesive circuitry that can stick to the skin and monitor biological functions. When augmented with power sources (possibly from body heat) and WiFi capability, such tattoo circuitry could allow all sorts of computer-human interactions. It's a clever way of converging electronic computing capability with biological behavior, disguised as the sort of thing you commonly see on sailors, NBA basketball players and anyone else enamored of personal epidermal artistic expression.

At first glance, the use of tattooish electronics to communicate via the skin seems beneficial and benign. Monitoring heartbeats, measuring brain waves and possibly offering better ways to manage artificial limbs all seem like sensible medical applications that the new technology may one day enable.

At second glance, you could imagine more frightening uses, like unrestrained instant-messaging streams of consciousness from one tattooed forehead to another. Or always having a cell phone or remote control not just in the palm of your hand, but on its skin. There's probably a downside to that.

No doubt more devious minds could devise any number of nefarious scenarios for pursuing malevolent motives by deceitfully exploiting the skin-based circuitry.

But let's face it, science's advances in technological skill always bring with them the potential for misuse (a sign of flaws in thinking suggesting that human brains might actually benefit from some electronic help). Besides, if you're worried about the human race turning into a real-life Borg collective, remember: When circuitry is involved, resistance is not futile — it's voltage divided by amperage.

— *Tom Siegfried, Editor in Chief*

JIM WEBB

Rarest of the Rare?

A watch collector's dream: The Stauer Eremos now available for only four payments of $49!

Take a good look. If you don't, you might miss this extraordinary watch forever. Designed using one of the most complex movements of all time, the ***Stauer Eremos*** is a regulator timepiece the likes of which you might never see again. That is, unless you decide to put one on your wrist for ***under $200!***

Let's get to the heart of the matter. The ***Stauer Eremos*** is one of the only watches on the market today based on the highly sought after observatory clocks of the 1800s. Those early timekeepers were amazingly precise thanks to separate hour and minute dials on the face. Stauer took a cue from those incredible machines and engineered what is essentially a miniaturized regulator. Most other watch companies don't even attempt to make regulators. But it was a challenge we were happy to accept. Still, due to the complexity of the movement, it takes 6 months to produce each piece.

We didn't stop there. Not only is the ***Eremos*** an astonishing 20-jewel automatic regulator with a separate minute dial and a unique scrolling hour display. It's also an open heart watch, revealing its balance wheel and escapement through a window in the elegant guilloche face. The ***Eremos*** is water-resistant to 3 ATM, has a classic sun and moon indicator that moves smoothly below the hour markers, and the case is crafted of gleaming stainless steel. A genuine croc-embossed black leather band adds the final touch of class. We don't know when another watch like this will be available (if ever) so you'd better act quickly!

The balance wheel and escapement can be seen under the Cotswold™ crystal and exhibition back.

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—George Thomas
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Say What?

diapycnal \dai-uh-PIHK-nahl\ *adj.* In the ocean, in or relating to the direction perpendicular to an imaginary surface of uniform density (the isopycnal). The diapycnal is often nearly vertical but can vary, because winds or tides can drive cold water—which is denser than warm water and normally sinks—to rise toward the surface. A British team reported April 22 in *Geophysical Research Letters* that diapycnal mixing (illustrated) in Northern Hemisphere seas can affect currents around Antarctica. Increased mixing in the Pacific and Indian oceans during glacial periods could have increased the amount of water moved by the Antarctic Circumpolar Current by about 30 percent, the authors suggest. —*Camille M. Carlisle*

Science Past | FROM THE ISSUE OF SEPTEMBER 9, 1961

NEW PARTICLE DISCOVERED — The discovery of a new elementary particle, omega meson, made at the University of California's Lawrence Radiation Laboratory, and the finding of unidentified additional "particle systems" in the subatomic realm are believed to make it possible to push on in the next decade or two to a better explanation of how matter is put together. More than 30 so-called elementary particles are known. The new elementary particle discovery gives important insight into the structure and behavior of the atomic nucleus. It plays an important role in the structure of protons and neutrons, the basic building blocks of atomic nuclei. The mass of the omega is 1540 electron masses. Like the neutron, the omega has no electrical charge.

Science Future

September 17–18
The World Maker Faire in New York City gives do-it-yourselfers a chance to invent and create new stuff. Visit makerfaire.com

September 21
Late September means Oktoberfest: Celebrate the history and science of beer with the Houston Museum of Natural Science. More at hmns.org

September 22
Goldie Hawn discusses education at the Cognitive Neuroscience of Learning meeting at Colorado's Aspen Institute. Go to aspenbrainforum.com

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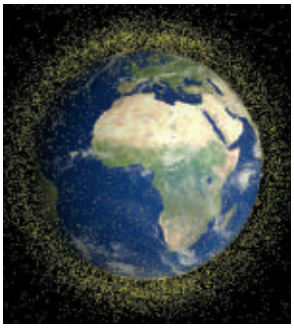
SCIENCE & THE PUBLIC BLOG
Space junk is lasting longer, making cleanup more urgent. See "Growing need for space trash collectors."



HUMANS
A 2,000-year-old human skull shows signs of having undergone surgery. Read "Ancient Saharan head cases."

Instant messaging can't replace the soothing sound of Mom's voice. See "Moms talk, daughters' hormones listen."

GENES & CELLS
Breaking bonds between protein buddies may help prevent Parkinson's. Learn more in "Parkinson's protein comes in fours."

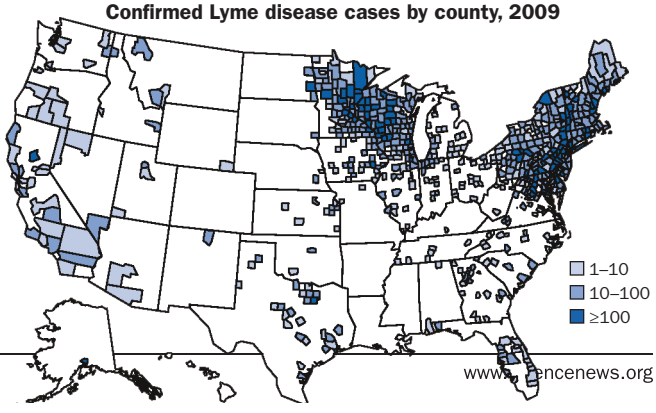
The (-est)

Astronomers have detected the oldest and largest water reservoir in the universe. The water is holed up in a cloud (illustrated) surrounding a gigantic black hole that sits in a galaxy that blazed brightly about 1.6 billion years after the Big Bang. Water is spread throughout the cosmos, but this oasis holds an amount equal to the mass of at least 100,000 suns—a fount about 4,000 times the Milky Way's stash. The results, reported by international teams in two papers to appear in *Astrophysical Journal Letters*, suggest that the disk of vapor surrounding the galaxy's central black hole is about 3,500 light-years wide. —*Camille M. Carlisle*

Science Stats | LYME CLIMB

About 90 percent of reported Lyme disease cases occur in the Northeast or upper Midwest, but cases were confirmed in 48 states in 2009. Total confirmed cases rose 3.6 percent from 2008 to 2009.

Confirmed Lyme disease cases by county, 2009



CLOCKWISE FROM TOP LEFT: B. MERRYFIELD/*SCIENCE* 2005; H. LEWIS/UNIV. OF SOUTHAMPTON; U.S. CDC 2011; NASA, ESA

“People have too quickly jumped to the conclusion that just because animals help each other, they are behaving altruistically.”
—RAGHAVENDRA GADAGKAR, PAGE 14

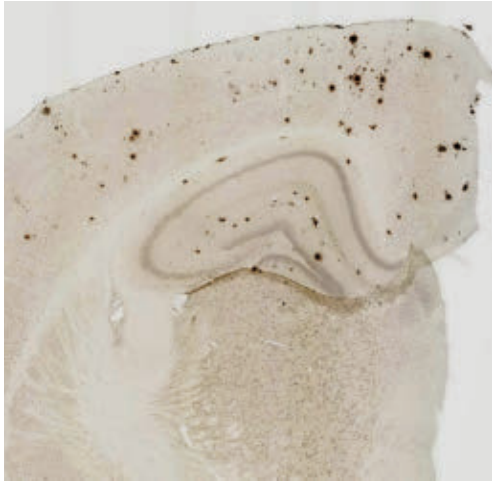
In the News

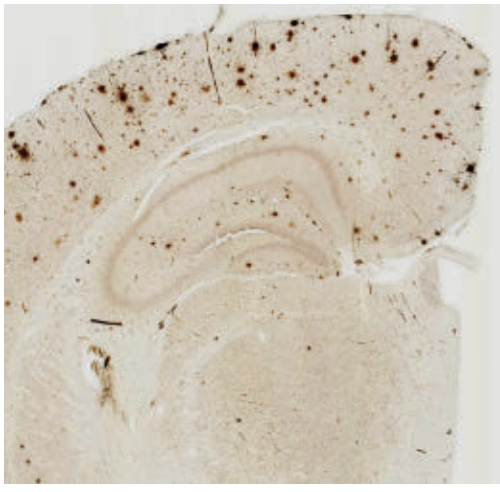
STORY ONE

Antidepressants show signs of countering Alzheimer’s

Mouse and human data link drugs to less plaque in brain

By Laura Sanders





After taking an antidepressant for four months, mice had less amyloid-beta plaque (brown clumps, left) in their brains than mice that didn’t take the drug (right).

J. CIRRITO *ET AL*./*PNAS* 2011

Widely used antidepressants may reduce the ominous brain plaques associated with Alzheimer’s disease, a new study in mice and humans finds.

Brain scans of people who have taken antidepressants reveal fewer clumps of the protein amyloid-beta, a target of Alzheimer’s prevention strategies, compared with people who have not taken the drugs.

Many in the field have voiced caution about the results. But if borne out by further study, the findings may point to a new, relatively safe way to treat and prevent Alzheimer’s disease, which is the sixth leading cause of death in the United States.

“I think this is a wonderful piece of news, and I think there’s going to be a lot of excitement about this,” says internist Michael Weiner, who leads the Alzheimer’s Disease Neuroimaging Initiative at the Veterans Affairs Medical Center campus of the University of California, San Francisco. “It points the way towards a possible approach to treating Alzheimer’s disease that people have not been talking about very much.”

In the study, mice genetically engineered to overproduce amyloid-beta, or A-beta, were given one of three selective serotonin reuptake inhibitors, a class of antidepressants that boost circulating levels of the chemical messenger serotonin in the brain. After a single dose of the antidepressants, A-beta levels dropped in the fluid that surrounds mouse brain cells, researchers report online August 22 in the *Proceedings of the National Academy of Sciences*. A full day after receiving the drug, the mice’s A-beta levels fell by nearly a quarter.

Long-term administration of the drug had a larger effect. Engineered mice that took the SSRI citalopram for four months had about half the A-beta plaques in their brains as mice that hadn’t received the drug. This reduction seems to happen through a protein called ERK, which serves as the middleman between brain cells’ serotonin-sensing proteins and A-beta production.

Figuring out the details of this process may open the door for developing new ways to prevent A-beta buildup, says study coauthor John Cirrito of the Washington University School of Medicine in St. Louis.

To see if a similar effect might be happening in people, the scientists scanned the brains of 186 cognitively normal elderly people and looked for signs of A-beta plaques. The team used a compound called PIB that binds to big clumps of A-beta in the brain and glows on a PET scan.

Of these participants, 52 reported that they had taken an antidepressant in the last five years. These people, researchers found, had about half the A-beta load in their brains as the people who hadn’t taken an antidepressant. What’s more, the length of time the participants took the drugs correlated with the density of A-beta plaques in the brain — the longer the antidepressant use, the less plaque.

“We think there are influences

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SN Today at **www.sciencenews.org**

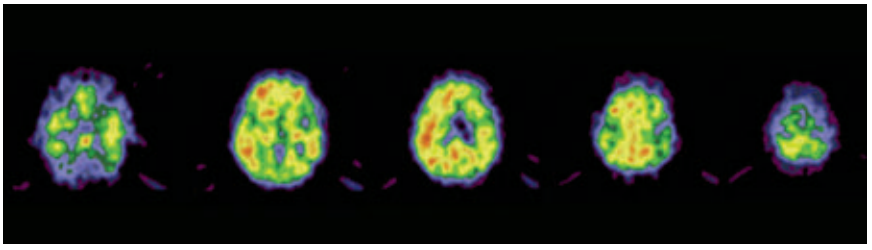
going in two opposite directions," says study coauthor and psychiatrist Yvette Sheline, also of Washington University. "We think depression pushes you toward dementia, but antidepressant treatment pushes you toward protection."

Finding similar results in mice and humans lends the study credibility, Weiner says. "When you have animal data and human data coming together, then you start to get really excited," he says.

Still, Weiner and others caution that it would be premature to conclude that antidepressants protect against A-beta buildup or that fewer plaques necessarily translate into less disease.

The study uncovered an association — not a clear-cut cause and effect, Weiner notes. "We cannot say with certainty that the reason why people who took the SSRIs have lower cortical amyloid is due to the fact that they took SSRIs," he says.

And molecular neuroscientist Heather Snyder of the Alzheimer's Association in Chicago points out that even if antidepressants are shown to reduce A-beta, scientists still don't know how A-beta levels affect the brain. "We don't really know what modulating amyloid will do to cognition," she says. "And we don't know if we need to reduce it by 10 percent or 20 percent, or if it needs to be completely reversed."



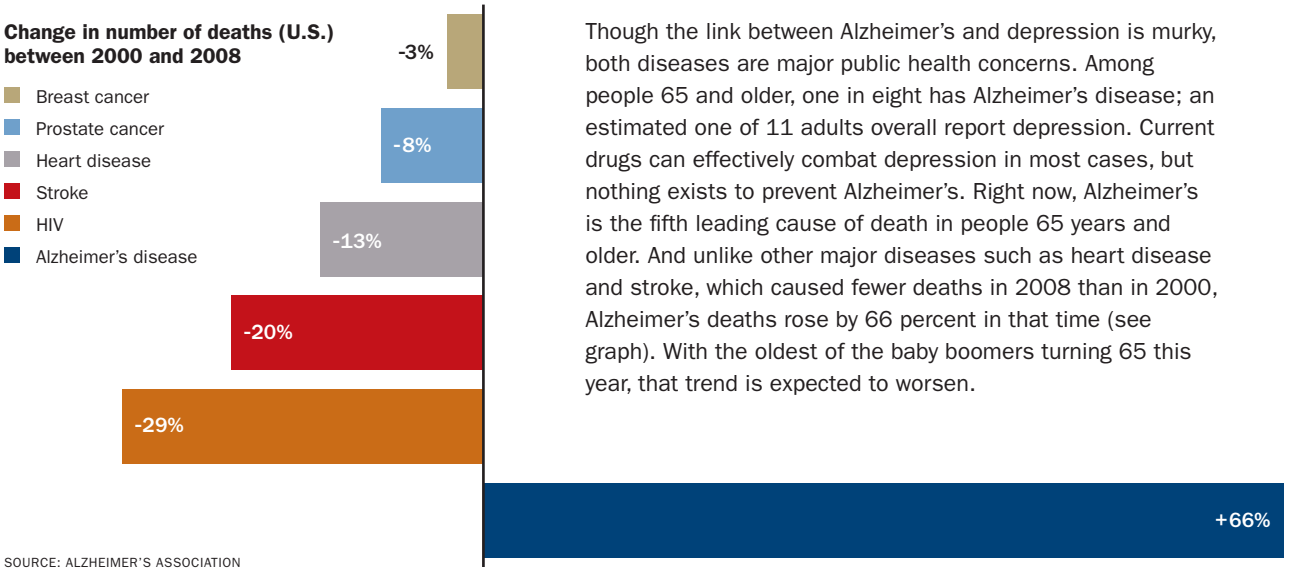
Researchers used a chemical called PIB to compare the amount of plaque in the brains of people who hadn't taken antidepressants with the amount in the brains of those who had. The images above show the PIB signal difference (red represents the most difference, blue the least) between the groups in horizontal slices, starting at eye level (left) and moving up to the top of the brain (right).

Another confounding factor is that A-beta can take several forms in the brain, from small molecules to large, sticky clumps, and some forms may be more dangerous than others. Interpreting the A-beta clumps that PIB detects in human brain scans remains challenging.

"We're being very cautious," Cirrito says. "There are a lot of people on these drugs, and we don't want to get anybody overly excited without reason." He and his colleagues plan to test whether acute doses of SSRIs change A-beta levels in the cerebrospinal fluid of healthy human subjects.

Even if the new findings are replicated in larger studies, a major question about Alzheimer's and antidepressants remains, Sheline says. "The real question is — which this paper sheds no light on — does that mean that long-term, they [SSRI-treated people] will have less of a risk of dementia? And that's exactly the big study that needs to be done." ■

Back Story | ALZHEIMER'S ON THE RISE



SOURCE: ALZHEIMER'S ASSOCIATION

Though the link between Alzheimer's and depression is murky, both diseases are major public health concerns. Among people 65 and older, one in eight has Alzheimer's disease; an estimated one of 11 adults overall report depression. Current drugs can effectively combat depression in most cases, but nothing exists to prevent Alzheimer's. Right now, Alzheimer's is the fifth leading cause of death in people 65 years and older. And unlike other major diseases such as heart disease and stroke, which caused fewer deaths in 2008 than in 2000, Alzheimer's deaths rose by 66 percent in that time (see graph). With the oldest of the baby boomers turning 65 this year, that trend is expected to worsen.

J. CIRRITO *ET AL./PNAS* 2011

Pioneering audiologist invents *reading glasses for your ears™*.

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Thank-you.
– G. Austin, MA

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Atom & Cosmos

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Magnetic waves turn up solar heat

Finding may explain why the sun's corona gets so hot

By Camille M. Carlisle

Scientists are getting warmer in their hunt for a reason why the sun's outer atmosphere is so hot. The key may be magnetic waves long sought but only recently spotted, an international team reports in the July 28 *Nature*.

Combined with observations reported earlier this year of high-speed gas jets shooting up into the sun's outer atmosphere, or corona, the magnetic waves may explain why the thin halo of superhot gas blazes at temperatures as high as a couple million kelvins. The waves may also account for the solar wind particles that stream off the corona at hundreds of kilometers per second.

"These are results that have been awaited for 50 years," says Peter Cargill of Imperial College London and the University of St. Andrews in Scotland.

Solar physicists have struggled all that time to understand how the corona can be so hot when the layer below it, the chromosphere, is much cooler. One theory is that waves traveling through the sun's magnetic field transport energy up from the seething solar surface. These oscillations move along magnetic field lines like vibrations on a plucked guitar string. In 2007 a team including Scott McIntosh of the National Center for Atmospheric Research in Boulder, Colo., finally detected these waves in the chromosphere. Now, using a sensitive instrument aboard NASA's Solar Dynamics Observatory, McIntosh and colleagues have discovered magnetic waves throughout the corona and the transition zone between it and the chromosphere.

Gas jets (green in this false-color image) and magnetic waves may superheat the sun's corona.

The energy supplied by the waves — equivalent to one or two 100-watt lightbulbs per square meter of the sun's surface — isn't much, but is enough to power the solar wind and explain the energy pouring out of parts of the corona with little or no flare activity. The waves can't account for the energy in active spots, but that could be a by-product of the way the spacecraft looks at the corona, Cargill and Ineke De Moortel of the University of St. Andrews suggest in a commentary in the same issue of *Nature*.

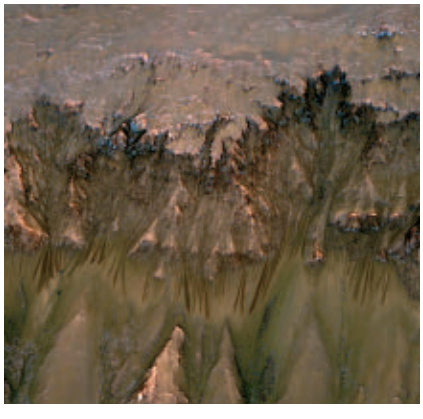
Fresh hints of salt water on Mars

Seasonal patterns consistent with presence of briny seeps

By Camille M. Carlisle

Salt water oozing from rocky outcrops may account for seasonal dark streaks on some Martian slopes, researchers suggest in the Aug. 5 *Science*.

The American and Swiss scientists haven't actually detected any water, frozen or liquid. Nor can they explain how the water would be replenished in the dry, harsh Martian environment. But given how the lines grow and fade each year with the seasons, the team's conclusion is "entirely justified," says Michael Hecht of NASA's Jet Propulsion Laboratory in Pasadena, Calif., who was not involved with the research. If the idea pans out, the stripes will add to previous evidence suggesting that salty water continues to be widespread on the Red Planet. So far, no one has found undisputed evidence of liquid water currently active on the planet's surface.



The dark streaks in this enhanced-color, 3-D image of Newton Crater's inner rim appear every Martian spring.

Looking at images from the Mars Reconnaissance Orbiter, the research team discovered lines that appear in late spring and grow throughout the summer, fading as the weather cools. Some look to be near small channels, and all are on steep bedrock, such as crater rims. Hundreds to thousands of the skinny streaks appear at seven sites that cluster in the middle southern latitudes, a location akin to the subtropics on Earth. The researchers spotted other candidate sites elsewhere, including to either side of the planet's equator.

Briny water melting and freezing just underground could explain these seasonal landscape patterns, the team argues. On Mars, liquid water would boil on the surface and freeze just below it, says study coauthor Alfred McEwen, a planetary geologist at the University of Arizona in Tucson. Brine would evaporate, too, but not as fast. And brine freezes at a lower temperature than pure water does, so it could stick around long enough as a liquid to leave a mark.

FROM TOP: AIA/SDO/NASA; NASA, JPL-CALTECH, UNIV. OF ARIZONA

"These are results that have been awaited for 50 years." —PETER CARGILL

Particle physicists chasing ghosts

Wispy neutrinos could explain lack of antimatter in universe

By Devin Powell

Two experiments on different continents have found hints that particles called neutrinos can shape-shift in an unexpected way.

This behavior may be the key to understanding why these particles are so weird, says neutrino physicist Jennifer Raaf of the Fermi National Accelerator Laboratory in Batavia, Ill., the nation's largest particle physics lab. Raaf presented an overview of recent neutrino findings on August 9.

The new results also bode well for future neutrino experiments that may one day help scientists understand why the universe contains vastly more matter than antimatter. These experiments are part of the changing landscape of U.S. particle physics: With Fermilab's Tevatron, once the most powerful particle collider in the world, shutting down soon, the government laboratory is reconfiguring itself to focus on projects that require particularly intense beams and look for extremely rare events.

"Neutrinos will play a big role moving forward," says Young-Kee Kim, deputy director at Fermilab.

In the bestiary of particle physics, each of the three charged leptons — the familiar electron and the heavier muon and tau particle — have electrically neutral neutrino counterparts. Neutrinos are loners by nature, rarely interacting with the rest of the universe. But they do occasionally change form. That process, called oscillation, may offer clues about why the universe contains so little antimatter.

In June the T2K experiment in Japan reported evidence that muon neutrinos occasionally oscillate into electron neutrinos. Six electron neutrinos appeared in a nearly pure beam of muon neutrinos traveling from an accelerator at the J-PARC facility to an underground detector 295 kilometers away.

Days later, physicists at the MINOS experiment announced finding traces of this oscillation in neutrinos traveling 735 kilometers from Fermilab to a mine in Minnesota. Those results, presented August 9, help to narrow T2K's estimate of how often this changeup happens.

> "Neutrinos will play a big role moving forward."
> YOUNG-KEE KIM

Taken together, the chance that both sightings are flukes is less than one in a thousand, according to a recent analysis by a team of physicists in Italy and Germany. That's below the standard for claiming a discovery but good enough to warrant further study, says Ed Kearns, a Boston University neutrino physicist and a member of the T2K team.

"This helps us justify future experiments," he says. "It makes a big difference in our confidence going forward."

If confirmed, this oscillation will be a crucial piece of information for a neutrino experiment now under construction at Fermilab. The NOvA experiment, which is currently testing its first prototype detector, could help scientists work out the differences in the masses of the different kinds of neutrinos, a long-standing puzzle.

Another project, called LBNE (for Long-Baseline Neutrino Experiment), also hopes to extend this line of research. LBNE would send beams of neutrinos and antineutrinos from Fermilab to a detector 1,300 kilometers away, giving the particles more time to change identity — and the scientists a better shot at understanding whether neutrinos behave differently than their antimatter counterparts.

MEETING NOTES

Dark energy camera getting ready for first light

Scientists have finished testing a camera that could sharpen up their picture of dark energy, a mysterious phenomenon thought to be pushing the universe apart. In late September, the 570-megapixel Dark Energy Camera will be boxed up, flown to Chile and mounted on the Victor M. Blanco Telescope at the Cerro Tololo Inter-American Observatory perched in the Andes, Jiangang Hao of the Fermi National Accelerator Laboratory in Batavia, Ill., reported August 11. There, the device will survey a broad area of the sky, taking snapshots of galaxies and supernovas to measure how the rate of the expansion of the cosmos has changed over time. More than 120 researchers from the United States, Brazil, Spain, Germany and the United Kingdom are involved in the project.

—Devin Powell

Gravity, meet antigravity

Like a prospective presidential candidate, gravity may flip-flop — transforming into antigravity that pushes instead of pulls. This new prediction comes from two-time physics, a theory developed by physicist Itzhak Bars of the University of Southern California in Los Angeles. In this theory, time is not linear but more like a flat sheet with two dimensions, and space contains an extra hidden dimension beyond the usual three. A universe moving through this six-dimensional spacetime would experience multiple Big Bangs and alternate between periods of gravity and antigravity, Bars reported August 12.

—Devin Powell

Technology

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Electronic tattoo merges circuitry with human skin

Adhesive devices may have uses in medicine, security

By Laura Sanders

Small electronic devices slapped onto the skin like temporary tattoos could presage an era where people have cell phones embedded in their throats and Internet browsers literally at their fingertips.

Described in the Aug. 12 *Science*, the gizmos were developed by researchers looking to create less obtrusive medical monitors for premature babies and other special-needs patients. But the technology's potential for integrating computers into the human body could be much broader.

"This goes beyond Dick Tracy calling someone with a cell phone on the wrist," says nanoengineer Michael McAlpine of Princeton University. "It's having the wrist itself house the device so it's always with you."

Study coauthor John Rogers of the University of Illinois at Urbana-Champaign and his colleagues converted brittle silicon to a more forgiving state by making it very thin. The electronic components — which can include light-emitting diodes, solar cells, transistors and antennas, among other things — were all constructed in a malleable net of wavy S-shapes similar to coiled telephone cords. That approach allows the circuits to work when stretched in any direction.

The researchers sandwiched these components between two protective layers of polyimide, a type of polymer. These layers sit on top of a rubbery silicone film that adheres to skin with weak chemical bonds. The device can also be applied in a temporary tattoo, which both disguises the grid and makes it stick longer.

Although Rogers is focused on medical applications, the basic components of the system can be configured in many ways for widely different uses.

"I think creative folks out there will think of things we haven't even contemplated," he says.

For example, the technology has drawn the interest of security-minded people who might be interested in using the electronics to develop a covert communication system. "CIA and others have been interested," Rogers says. A tiny hidden patch of electronics on the throat, for instance, could detect and transmit muscle activity that represents words, all without the person making a sound.

The superthin electronic skin wrinkles, puckers and stretches just like the body's skin, making it less intrusive than the bulky wires and cumbersome electrodes typically used to monitor vital signs.

The adhesive electronics pick up signals from people's heartbeats when stuck on the chest, skeletal muscle activity when stuck on the leg and brain waves when stuck on the forehead.

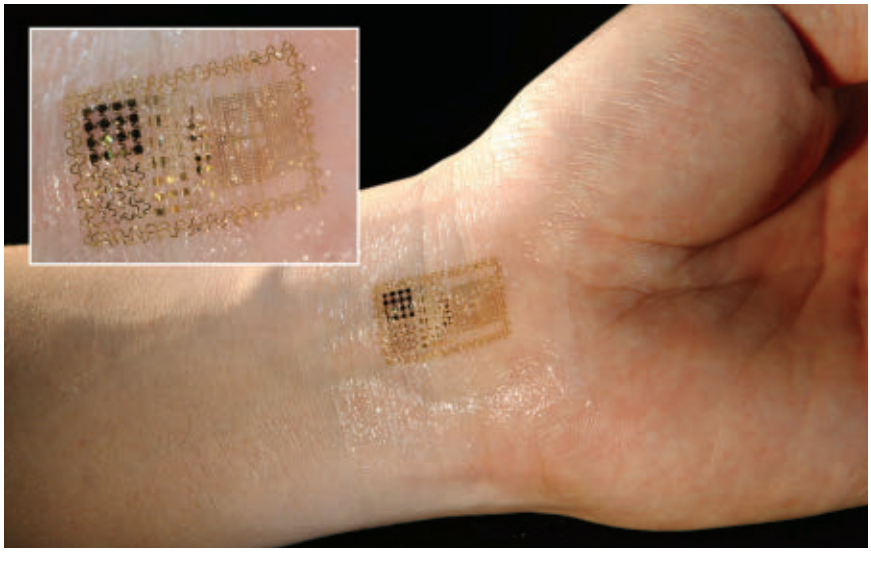
In the study, signals from the body traveled from the device along a thin wire to a computer. The patches collected data accurately for up to six hours, and showed no signs of degradation or irritation to the arm, neck, forehead, cheek or chin after 24 hours. The researchers think this life span could be extended, particularly if a strong adhesive is used. But Rogers points out that long-term use of the device is limited because skin cells periodically slough off.

The researchers plan to improve the technology by enabling wireless communication and adding ways to store power. The device already has the capability to get power from wireless coils and solar cells. In the future, such electronics could be designed to power themselves with stray electromagnetic signals or even energy from body heat.

Stretchable, nonintrusive monitors could be particularly helpful for premature babies, Rogers says. The electrodes and monitors now used to track neonatal babies' vital signs are large and may irritate fragile newborn skin.

Such monitors might also help people undergoing sleep studies. The bulky electrodes that measure brain waves often interfere with the sleep the doctors are trying to evaluate.

The potential medical applications of the flexible electronics aren't limited to monitoring. The electronics could offer better control of prosthetic limbs and ways for people with larynx disease to communicate.



A thin, flexible electronic device that sticks to skin may have multiple applications.

COURTESY OF J. ROGERS

"This goes beyond Dick Tracy calling someone with a cell phone on the wrist." —MICHAEL MCALPINE

Brain waves assist faster braking

Monitoring neural patterns may reduce driver response time

By Laura Sanders

In a fast-moving car, the brain can hit the brakes faster than the foot. By relying on brain waves that signal the intent to jam on the brakes, a new technology could shave critical milliseconds off the reaction time, researchers report online July 28 in the *Journal of Neural Engineering*.

In the study, computer scientist Stefan Haufe of the Berlin Institute of Technology and his colleagues measured brain wave changes while participants drove in a car simulator. Participants drove about 60 miles per hour following a lead car on a curvy road with heavy oncoming traffic. Every so often the lead car would slam on its brakes, so that the participants would have to either do the same or crash.

For most drivers, the lag between the lead car stopping and slamming on the brakes was around 700 milliseconds. Particular neural signatures were evident during this lag time.

Haufe and his colleagues designed a system that detected and interpreted these neural patterns.

In computer simulations, the system, which included data from measures of leg-muscle electrical activity, performed about 130 milliseconds faster than an unaided driver, the team reports. For a car traveling at 60 miles per hour, this time difference translates to about 3.7 meters of stopping distance — the length of some compact cars.

At peak performance, the system would incorrectly slam on the brakes almost two times per hour, a false alarm rate that needs to come down if the system is going to be useful, says cognitive neuroscientist Raja Parasuraman of George Mason University in Fairfax, Va. "Even a 1 percent false alarm rate would not be acceptable to most people," he says.

As part of an effort to develop an automated braking system, researchers record brain activity from a cap worn by participants driving in a simulator.

S. HAUFE ET AL/J. NEURAL ENGINEERING 2011

Genes & Cells

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ADHD linked to rare gene counts

Missing or added copies also seen in other brain disorders

By Tina Hesman Saey

Rare genetic factors that may lead to attention-deficit/hyperactivity disorder appear to be some of the same ones that are related to autism, schizophrenia and other brain disorders.

Previous studies have attempted — and mostly failed — to link common genetic variants to attention-deficit/hyperactivity disorder, better known as ADHD. A new study bolsters the idea that many different rare variants, some found only in single families or individuals, can be responsible for the condition. What's more, variants of the same genes associated with ADHD have also been linked to autism spectrum disorders, schizophrenia and bipolar disorder.

"This really gives substance to the argument that there are shared genetic links between neuropsychiatric disorders," says Russell Schachar, a child psychiatrist at the Hospital for Sick Children in Toronto, who led the study with Stephen Scherer, a geneticist at the hospital.

ADHD affects about 7 percent of school-age children in the United States. It persists throughout life. People with the disorder may have trouble concentrating, act impulsively and be overly active. Symptoms fall on a continuum of severity, much like high blood pressure, says Josephine Elia, medical codirector of the Center for Management of ADHD at Children's Hospital of Philadelphia.

Up to 75 percent of people with autism spectrum disorders also have symptoms of ADHD, but researchers did not know if the genetic causes were the same as in people who have ADHD alone. Previous research has shown that people with autism or schizophrenia tend to have more missing or duplicated genes than usual. Healthy people may have extra copies of several genes or lack some entirely, but missing or doubling up on certain genes can lead to disease. These differences in gene number are known as copy number variations.

Unlike people with schizophrenia or autism, people with ADHD are no more likely than average to have missing or duplicate gene copies overall, the researchers report in the Aug. 10 *Science Translational Medicine*. But about 8 percent of people with ADHD have missing or extra copies of certain genes that may cause or contribute to the disorder. A subset of those genes are perturbed both in people with ADHD and in people with autism spectrum disorders, indicating that the disorders may have some common genetic causes.

An examination of DNA from parents of 173 of the children in the new study showed that ADHD-associated gene copy differences are frequently inherited from a parent who also has the disorder. That differs from autism and schizophrenia, where the genes associated with the condition are often newly deleted or duplicated in the child with the disorder, not passed down from parents.

More variants and other genetic changes remain to be uncovered. Many brain processes are probably involved in the disorders, and disrupting any of them could produce similar outcomes, Elia says. "We may end up having thousands of variants and not just a handful."

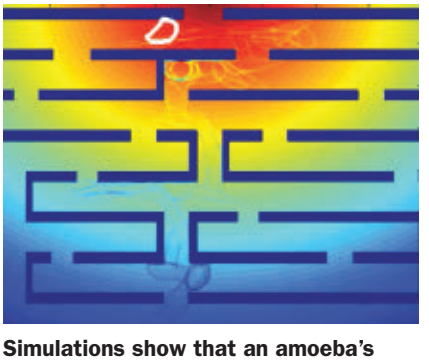
Cells may navigate with trail marks

Secreted molecules could help steer cellular migrations

By Nadia Drake

Cells seeking paths through the body's tangle of tissues might adapt the navigational strategy of Hansel and Gretel, who dropped pebbles and bread crumbs to help lead them out of a freaky forest.

Instead of using markers telling them where to go, though, cells might use repellent molecules telling where not to go. In a new study, scientists suggest these markers help trailblazing cells move away from areas where they've gotten stuck.



Simulations show that an amoeba's success at moving through a maze can be aided by chemical repellent markers dispensed by the cell along its way.

I. HECHT

Cells moving through complex environments are directed, in part, by spatial differences in chemical concentrations, known as gradients. But the gradient alone isn't enough to explain successful cell navigation in complex situations, says physicist Inbal Hecht of Tel Aviv University in Israel, who coauthored the study appearing August 4 in *PLoS ONE*.

Hecht and colleagues used a simulated gradient and a computerized version of the amoeba *Dictyostelium*. The team had the amoeba find its way from one end of the gradient to the other, and put mazes and other obstacles in its way.

On its own, the computerized amoeba made it through the maze only 30 percent of the time. When it could secrete repellent markers, the amoeba's success rate rose to 99 percent.

"This is really a proof of principle," says physicist and coauthor Eshel Ben-Jacob of Tel Aviv University. Real cells probably use more complex strategies, he says.

Environment

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Cracked sewers leak fecal germs

Studies follow sewage into waterways and drinking supplies

By Janet Raloff

New studies in California and Wisconsin reveal a dirty little secret: Out of sight, many urban sewer pipes are failing, allowing germ-ridden filth to bleed into storm drains. These drains, which channel their contents into streams and coastal waters, are designed to collect fairly clean rainwater and runoff from watered lawns. Yet raw sewage at times constituted 17 percent of one local storm drain's flow, report Patricia Ann Holden of the University of California, Santa Barbara and her colleagues.

"We found the same thing," says Sandra McLellan of the University of Wisconsin–Milwaukee. In the August *Water Research*, her group reports finding a bacterial indicator of human feces in samples from all 45 storm water outflows in the Milwaukee area that the researchers monitored over four years. The data show that sewage contamination "is nearly ubiquitous in the urban environment," McLellan says.

In Santa Barbara, Holden's team added a fluorescing dye to sewage. Using an automated sensor, the researchers looked for the telltale dye in nearby storm drains.

New studies find sewage contamination is widespread. Green dye exiting this Wisconsin storm drain was originally added to an upstream sewer pipe.

In one system, the dye showed up in storm drains within a half hour. In a second, it took between two and 74 hours for the dye to emerge in storm water. In both instances, two other bacterial indicators of human feces accompanied the dye, the California scientists report online July 25 in *Environmental Science & Technology*. In a third system, where the apparently leaky sewage pipes lay below storm drains, no dye or germs appeared to be wicked up into storm water pipes.

The California study "definitively links leaky sewers to problems with water contamination of rivers, oceans and lakes," says Marc Edwards of Virginia Tech in Blacksburg. "It informs our understanding of how decaying water infrastructure can threaten human health and the environment, and helps in prioritizing investment to mitigate these risks."

Bacteria gobbled oil, didn't grow

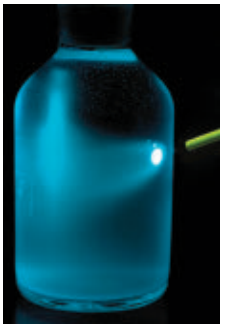
Spilled BP crude may not have provided balanced diet

By Janet Raloff

When the *Deepwater Horizon* accident spewed millions of barrels of oil into the Gulf of Mexico last year, surface bacteria launched into a feeding frenzy, a new study finds. But microbes that gobbled up the surface oil did so without increasing their numbers or gaining weight.

Waters in much of the Gulf are fairly mineral-poor, at least in terms of what microbes need to flourish, says chemical oceanographer Benjamin Van Mooy of the Woods Hole Oceanographic Institution in Massachusetts. He and his team expected that microbes encountering the oil slick would turn up their figurative noses. To the scientists' surprise, local bacteria pigged out, more than quintupling their normal daily intake with no increase in their mass. The researchers describe their findings online August 3 in *Environmental Research Letters*.

The Woods Hole researchers sampled water from five sites inside the surface slick and seven more upwind. They dumped water from six of the sites into gas-tight jars that contained a new kind of molecular sensor. Shining light on this sensor induced a fluorescent readout of the water's oxygen content. Because bacteria use fairly predictable amounts of oxygen when they break down oil, oxygen depletion offered an indirect measure of the bugs' dining rate.



Scientists used this laser-based system to monitor the eating habits of microbes in the Gulf.

Enzyme measurements confirmed that Gulf bacteria — and especially the gorging diners inside the slick — suffered from a shortfall of phosphorus, a nutrient essential for growth. Offering affected bacteria extra phosphorus greatly boosted their feeding rate and their proliferation. But even without the dietary aid, the team found, it appeared Gulf microbes were breaking down oil at an unprecedented rate.

The new findings "are very interesting but not totally surprising," says Terry Hazen of Lawrence Berkeley National Laboratory in California. Although oil degradation in the slick proceeded faster than had been expected, he says that the rapid rate may reflect the bugs' adaptation over millions of years to the large number of natural oil seeps in the Gulf of Mexico.

TOP: S. MCLELLAN/UW-MILWAUKEE; BOTTOM: TOM KLEINDINST/WHOI

Life

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Plesiosaur fossil hints at live births

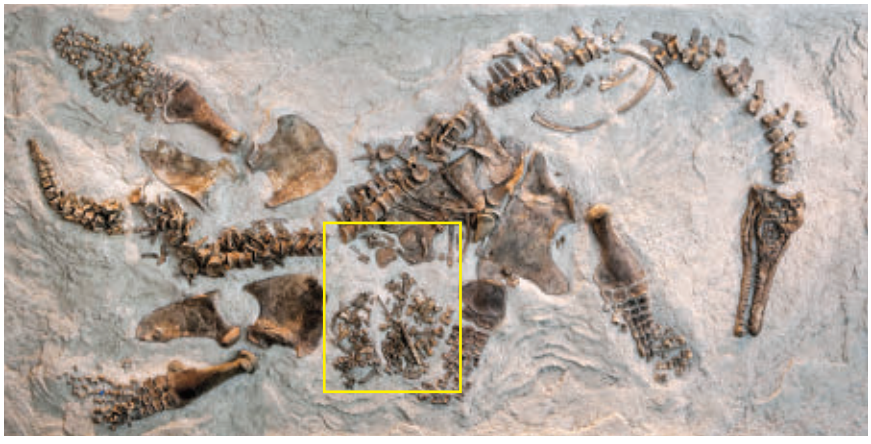
Fetus remains suggest that ancient reptiles had big babies

By Nadia Drake

The fossil of a pregnant plesiosaur who died 78 million years ago indicates that the ancient sea monsters were surprisingly like today's marine mammals.

The aquatic, carnivorous reptiles gave birth to live young, a team reports August 12 in *Science*. And plesiosaurs probably birthed just one plesio-baby at a time — one very big baby, estimated to be more than 40 percent of the mother's body length at birth. Putting so much effort into a single offspring suggests that, similar to modern marine mammals, plesiosaurs offered a bit of postnatal maternal care.

"If you're going to put all your eggs in one basket, then you're going to want to take care of that egg when it comes out," says paleobiologist F. Robin O'Keefe of Marshall University in Huntington, W.Va.



This enormous fossil of a pregnant plesiosaur contains the nearly complete maternal skeleton of the extinct sea creature and roughly 65 percent of the fetus (box).

The fossil, an enormous *Polycotylus latippinus*, was excavated in Kansas nearly 25 years ago. Called "Poly" by the team, the 4.7-meter-long creature was carrying a fetus. O'Keefe verified that the fetal bones were the same species as Poly, and not the remains of an animal she had ingested.

"The preservation is outstanding, but tantalizing for what is missing," says paleobiologist Michael Caldwell of the University of Alberta in Edmonton. "The adult is perfect, but the embryo is quite incomplete. And so we are missing the interesting juvenile features that would tell us more about plesiosaur [development]."

Wasps' apparent altruism isn't

Females' gamble benefits their own reproductive success

By Susan Milius

Acts of apparent altruism in European paper wasps can be explained by plain old self-interest, a new study finds.

Polistes dominulus females can either establish their own nests to raise young or join other females for joint homemaking. In those joint nests, though, one female does most of the egg-laying while the others do most of the drudge work in taking care of the top wasp's young.

When a subordinate helps her sister, her reproductive success includes an indirect share of her sister's brood. Forgoing her own direct offspring counts as a kind of altruism. But some 15 to 35 percent of cofoundresses slaving away are not closely related to the top wasp.

It turns out that joining an unrelated queen's nest offers a chance of grabbing the throne, says Ellouise Leadbeater of the Zoological Society of London. She and her colleagues tracked the fortunes of 1,113 foundresses in 228 nests in southern Spain.

Females that started out as subordinates to a nonrelative occasionally took over the whole nest and laid their own eggs. Their triumphs were rare but dramatic enough so that, overall, the strategy worked out better than being a single mom: Lone nest foundresses hardly managed to produce any offspring, the researchers report in the Aug. 12 *Science*.

"People have too quickly jumped to the conclusion that just because animals help each other, they are behaving altruistically," says Raghavendra Gadagkar of the Indian Institute of Science in Bangalore.

***Polistes dominulus* foundresses build a nest. Serving under another queen suits the wasps' reproductive interests.**

FROM TOP: © NATURAL HISTORY MUSEUM OF LOS ANGELES COUNTY; JASPER VAN HEUSDEN

Plants and fungi reciprocate favors

Rewards for rewards stabilize underground biological market

By Susan Milius

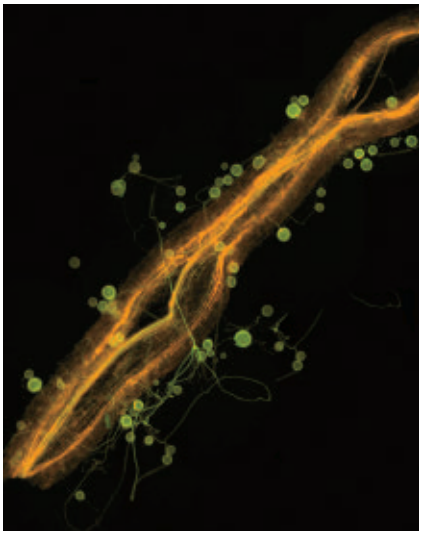
One of the biggest underground markets on the planet — nutrient trading between plant roots and fungi — turns out to run on a system of reciprocal rewards for good suppliers and less business for bad ones.

"It may have taken 450 million years to evolve," says Toby Kiers of VU University Amsterdam, "but unlike most human markets, here we have an example in which cheaters actually get punished and the good guys get rewarded."

Most land plants participate in this exchange, as threads of specialized fungi wind into plant root tissue and form structures called arbuscular mycorrhizae. About 4 to 20 percent of the carbon compounds that a plant produces from capturing the energy of sunlight flows into the fungus. In the other direction, minerals and other useful compounds flow from the fungus into the plant.

Other cross-species mutualisms have turned out to have a lopsided power balance in which one partner, often a plant, can kill a misbehaving helper. In the arbuscular mycorrhizal system, though, plant roots can detect which fungus threads are providing an abundance of a mineral and in turn reward them with extra nutrients in the form of plant-produced carbon. And the fungi also can detect and preferentially reward a good supplier and shun a slacker, Kiers and her colleagues report in the Aug. 12 *Science*.

Researchers first looked at whether a plant in the bean family, *Medicago truncatula*, could distinguish between different closely related fungi known to provide different amounts of phosphorus to partners. To see, researchers let the fungi wind intimately around the plant roots and then labeled the carbon flowing through the fungal-plant snarl with a heavier than normal isotope. Analyzing RNA molecules from the fungi revealed where more of the heavy carbon had gone. The plant had indeed given more carbon to the more generous fungus species.



Arbuscular mycorrhizal fungi (green) and *Medicago truncatula* (roots in yellow) reciprocate in nutrient trading.

JAN JANSA, © SCIENCE/AAAS

To see if fungi would respond likewise, researchers set up lab dishes with compartments that forced some plant roots to cheat by restricting the amount of carbon they passed on. Other roots acted as good-guy partners for the fungi. "I think we were all rooting for the underdog, hoping the world has thus far underestimated the bargaining power of fungi," Kiers says. And yes, the fungi did pass along more of their phosphorus to the generous suppliers.

Major steps in evolution often depend on the rise of ways to stabilize cooperation between organisms, says Ronald Noë of the University of Strasbourg in France, who studies biological markets. "You wouldn't exist without mutualisms, and you would have little to eat without the arbuscular mycorrhizal fungi."

NEWS BRIEFS

Fruit of the loo

One of nature's toilets uses fruity odors to lure furry critters to its dangerous rims. In Borneo, the carnivorous pitcher plant *Nepenthes rajah* is a favorite throne for tree shrews and rats. While perched on the pot, animals simultaneously lick the plant's lid and deliver a nutrient-rich poopy present. And animals occasionally drown in the bowl, which is filled with soupy digestive juices, insects and fecal matter. Now, scientists from Germany and Malaysia think they know what keeps small mammals coming back to these toilets: The lid exudes hydrocarbons, esters, ketones and alcohols — compounds that produce a tempting fruity or flowery fragrance, the team reports in July's *Journal of Tropical Ecology*. — *Nadia Drake*

Leafy beacons beckon bats

Even though they're not as flashy as their floral neighbors, plain old leaves can attract pollinators, too. Bats bounce echolocation signals off leaves growing on the bat-pollinated Cuban rain forest vine *Marcgravia evenia*, scientists from Germany and Britain report July 29 in *Science*. An odd, dish-shaped leaf hangs above the vine's ring of flowers. Shooting simulated echolocation calls at the leaf produced a strong, multidirectional and invariant reflection. Removing the leaf doubled the foraging time of nectar-feeding bats. The leaf's strange shape and orientation affect its photosynthetic efficiency, but scientists think that the cost is balanced by the benefits of aiding bat pollination.
— *Nadia Drake*

Body & Brain

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Herpesvirus gets to brain via nose

Olfactory cells provide path for virus, researchers suggest

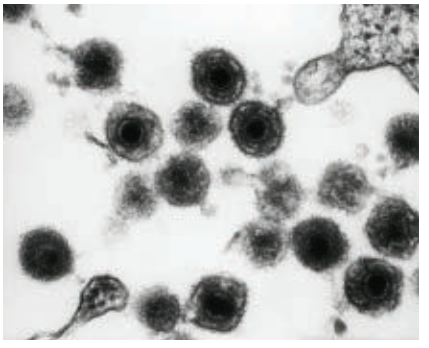
By Laura Sanders

After setting up shop in people's nasal mucus, human herpesvirus 6 may travel along olfactory cells right into the brain, researchers report August 16 in the *Proceedings of the National Academy of Sciences*.

HHV-6 causes the common childhood infection roseola, marked by a chest rash and a high fever. "Everyone is exposed to this," says study coauthor Steven Jacobson of the National Institute of Neurological Disorders and Stroke in Bethesda, Md. "You have it. I have it."

Despite the virus's ubiquity, very little is known about it. In some people (researchers don't know how many), the virus can infect the brain, where some scientists believe it may contribute to neurological disorders such as multiple sclerosis and a form of epilepsy.

Other viruses such as herpes simplex, influenza A and rabies can invade the brain by shooting through the nose, so Jacobson and his team wondered whether HHV-6 could do the same.



Human herpesvirus 6 (shown in an electron micrograph) infects most people during infancy or toddlerhood.

Researchers found high levels of HHV-6 in the olfactory bulb, a smell-related part of the brain, in two of three autopsy brain samples. The team then looked at nose mucus and found the virus in 52 of 126 samples. "We were surprised to find so much in the nasal mucus," Jacobson says.

In a lab dish, specialized cells that help connect nerves in the nasal cavity to the brain were susceptible to HHV-6 infection, the team found. These cells might be a route of entry for the virus, Jacobson says.

"Viruses take advantage of whatever they can," says NINDS neurologist Avindra Nath, who was not involved in the study. "They'll try to gain entry any way they can, so it's not surprising that they'd use nasal mucosa to do so."

The study presents data on a small number of samples, cautions neuroimmunologist Robyn Klein of Washington University School of Medicine in St. Louis, so it's hard to say whether HHV-6 really travels along an olfactory pathway into the brain. Confirming the nose-to-brain passage is important, Klein says, because a virus's entry point to the brain may have a big impact on the infection's outcome.

Apnea linked to later dementia

Sleep disorder may cause cognitive decline in women

By Nathan Seppa

Breathing irregularities that rob the brain of oxygen during sleep may imperil a person's ability to think straight. A study of women 65 and older finds that those with seriously disordered breathing have an increased risk of developing mild cognitive impairment or dementia in subsequent years, researchers report in the Aug. 10 *Journal of the American Medical Association*.

People with disordered breathing slow down or stop taking breaths during sleep and often gasp to catch up. The condition includes sleep apnea, an abnormal pattern that deprives the brain of oxygen and intermittently interrupts the deep sleep needed for satisfying rest.

Previous short-term studies have linked disordered breathing to cognitive impairment, but long-term data have been lacking.

In the new study, physician Kristine Yaffe of the University of California, San Francisco and her colleagues tested 298 women an average of 82 years old for sleep problems. None of these women were cognitively impaired at the time of the sleep test. The researchers monitored each woman overnight and noted any stoppages of airflow in their breathing as well as arousals from sleep. About one-third of the patients had disordered breathing.

When researchers repeated standard cognition tests on the women roughly five years later, 45 percent of those who had disordered breathing had developed dementia or milder cognitive impairments, compared with 31 percent of those with no breathing irregularities.

In particular, women who had 15 or more breathing stoppages per hour and who spent more than 7 percent of sleep time not breathing during the earlier part of the study were nearly twice as likely as those without breathing problems to develop dementia or other cognitive impairments. Such problems can include forgetfulness, confusion and reasoning troubles.

"Clearly, hypoxia isn't good for the brain," says Brian Murray, a neurologist at Sunnybrook Health Sciences Centre and the University of Toronto, who wasn't involved in the study. "This is a huge problem, and it does have very significant public health implications."

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Flying on sunshine

Once futuristic visions, solar sails now take off

By Alexandra Witze

When it comes to futuristic space travel, few concepts are more romantic than sailing on sunlight. Soar above Earth, unfurl a jib and tack your way through the solar system all the way to interstellar space.

Solar sails have been a mainstay of dreamers since Johannes Kepler, who speculated four centuries ago that ships would one day be powered by "heavenly air." But sun sailing is no longer fanciful fodder for visionaries. Recent technological advances have moved solar sailing from science fiction to science fact.

Last year, Japan's space agency launched the world's first solar sail into interplanetary space; its metal-coated membrane unfurled and caught the light to begin sunjamming. And with help from tiny "nanosatellites" that allow scientists to pack folded-up sails in spacecraft no bigger than a loaf of bread, NASA this year sent its first sail skipping through Earth orbit. Look overhead at the right time of night, and you can spot the gleaming streak of NASA's NanoSail-D as it tumbles closer to Earth, mission accomplished. Within the next few months it will incinerate in the atmosphere in a bright flash.

In addition to the Japanese and U.S. efforts, the privately funded Planetary Society expects to launch its own sail next year, as does a satellite design team based at the University of Surrey in England.

After keeping scientists in suspense, NASA's NanoSail-D (illustration shown) fanned out in space earlier this year.

Solar sail enthusiasts have waited decades to see such flights. And one day, they hope, solar sails will perform tasks other spacecraft cannot: hover above Earth's poles to monitor climate change, flit near the sun to watch for solar storms, drag space junk out of orbit like a cosmic maid or even journey to a nearby star.

"As far as solar sails go, we are on the cusp of history," says Dean Alhorn, an engineer at NASA's Marshall Space Flight Center in Huntsville, Ala., who

MSFC/NASA

leads the NanoSail-D mission. "We are ready now with the technology to make these happen."

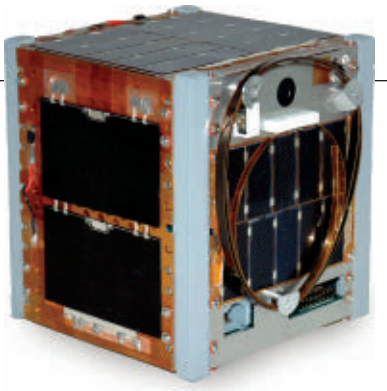
Riding the wind

In principle, solar sailing could not be easier. Scottish physicist James Clerk Maxwell described in 1873 how light can exert pressure: A particle of light transfers up to nearly twice its momentum to an object it bounces off of.

Each individual transfer amounts to no more than a mosquito's breath, but over time that breath accumulates to a steady wind that a spacecraft can ride just as a sailboat rides the wind on Earth. After 100 days, a solar sail could reach 14,000 kilometers per hour; after three years it could be zipping along at 240,000 kilometers per hour. At that rate it could get to Pluto in less than five years, rather than the nine years the plutonium-powered New Horizons spacecraft, now on its way, is taking. Solar sails are the tortoise to the hare of chemical rocketry.

Scientists have long wanted such a tortoise. In the 1920s Konstantin Tsiolkovsky, the founder of Soviet astronautics, and colleague Fridrikh Tsander separately wrote of the idea of using solar radiation pressure to accelerate sails. After a few decades on the back burner, the idea took off in the '50s and '60s, with engineers drafting up grandiose designs and Arthur C. Clarke plotting a solar sail race in his short story "The Wind from the Sun." By 1976 engineers at NASA's Jet Propulsion Laboratory in Pasadena, Calif., were dreaming of sending a massive solar sail to fly alongside Comet Halley as it passed close to Earth the next decade.

Without the need to carry fuel, solar sails promised to be a cheaper way to explore Earth and its environs. They could also make visits, such as hovering above the North Pole, that traditional spacecraft can't because of the dictates of gravity. But solar sails lost the funding battle to other alternative propulsion systems — at least in the United States. By the early 1990s a few other sporadic attempts, including a plan for a solar sail race to Mars, also fell apart.



A CubeSat like this one has carried solar sails into space. Once there, the sails unfurl and begin sunjamming.

Now, tiny satellites may be saving the big dreams of some would-be solar sailors. One of the hottest things in satellite technology today is the CubeSat, a box just 10 centimeters on a side that weighs about 1 kilogram. Such boxes can be mixed and matched in "nanosatellite" combinations of up to three cubes yet still be launched using a shared deployment system. CubeSats are thus relatively cheap and easy to work with, so researchers have used them to carry a variety of science experiments. A small solar sail, thinner than a trash bag and weighing just grams, turns out to be nearly the perfect payload to fly on a CubeSat.

"When we first thought of solar sails back in the '70s and '80s, it was these huge structures, a mile or half a mile on a side," says Louis Friedman, cofounder of the Planetary Society, headquartered in Pasadena. "That was kind of unimaginable. Now that we're talking about things 5 meters or 10 meters on a side, you realize that a lot of people might be able to build them and use them a little more practically."

Two flights and failure

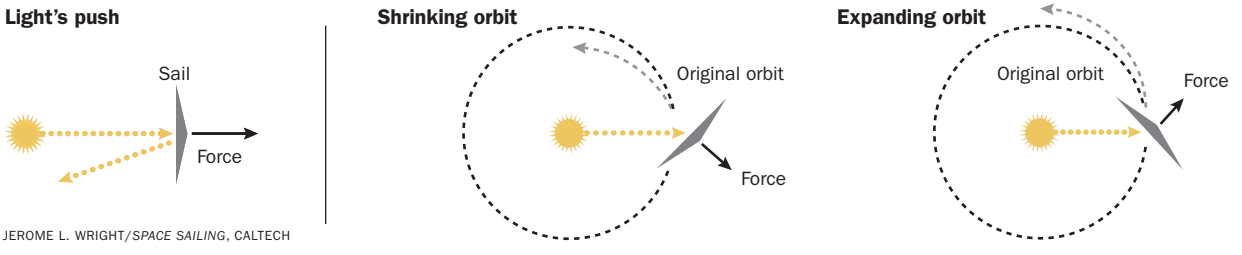
Existing solar sail designs fall into two main categories: ones that deploy rigid booms to hold the sail taut, like a sailboat's mast, and ones that spin to blossom sail blades outward using centrifugal force. The main challenges are to unfold the whisker-thin sail in space without ripping, and to direct the sail to move in the right direction.

Thanks to hefty government funding, Japan's space agency, JAXA, was the first to conquer both challenges. It built a large square sail, too big to fit in a CubeSat, and launched it on board a probe headed to Venus. In June of last year, the probe released the still-folded solar sail, named IKAROS after the mythological boy who flew too close to the sun and melted the wax anchoring his wings. In the great space acronym tradition, the name also stands for Interplanetary Kite-craft Accelerated by Radiation Of the Sun.

On cue, IKAROS unfolded its sail, 20 meters across diagonally, and made its way toward Venus, flying past that planet in December. By turning on and off an innovative set of liquid crystals, project engineers showed they could change the sail's reflectivity and thus direct its motion.

JAXA has extended the mission to March 2012 so engineers can test some more risky flight maneuvers. "I'm just so in admiration of them," says Friedman.

Driving a solar sail A solar sail gets its momentum from particles of light hitting it and bouncing off. By tilting the sail so the photons hit at different angles, the sail can be made to fall in toward the sun (a shrinking orbit) or travel outward (an expanding orbit).



SOURCE: JEROME L. WRIGHT/*SPACE SAILING*, CALTECH

TOP: NAKASUKA LAB/UNIV. OF TOKYO; BOTTOM: ADAPTED BY JANEL KILEY

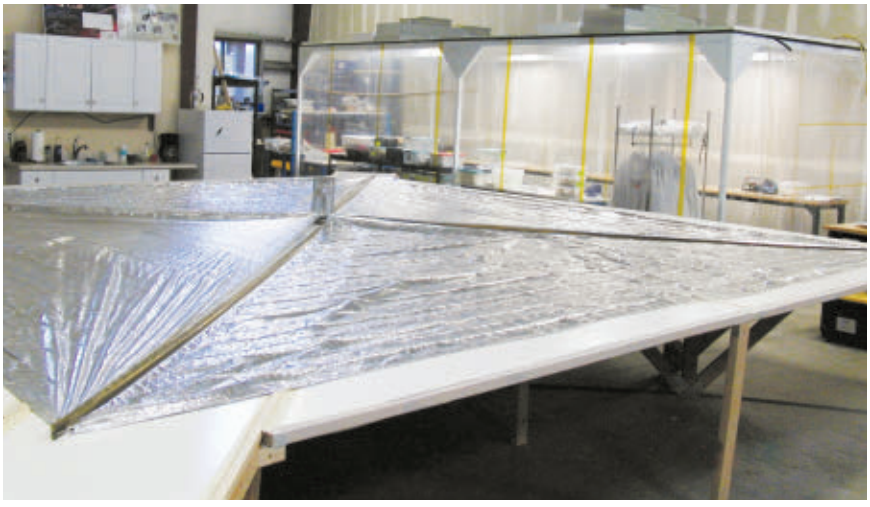
The agency is also working on a much larger solar sail, 50 meters across, with hopes of launching it around 2020 to set sail for Jupiter and distant asteroids. Eventually, JAXA wants to develop novel hybrid propulsion systems, combining solar sails with ion drives to enable long trips through the solar system.

With far less money to spend than Japan, the first U.S. solar sail is far smaller, cheaper and less ambitious. Like so many projects in the solar sail world, the currently orbiting NanoSail-D was born from the ashes of much grander ideas.

NASA's solar sail research program has waxed and waned over the years depending on funding. In the middle of the last decade, the agency conducted its biggest experiment to date, when it tested two 20-meter-by-20-meter solar sails at a research facility in Ohio. Then NASA began funneling most of its money into the Constellation program to return astronauts to the moon, and the big solar sail project foundered.

"When that ended we had a lot of hardware and only a little budget," says Les Johnson, deputy manager at the Advanced Concepts Office at the Marshall center. "And that's where NanoSail-D was born."

A few people began working on a CubeSat-based design informally called LunchSat, "because the only time people had to work on it was during lunch," Alhorn says. But suddenly a chance to launch arose, and the team hurriedly built two kite-shaped sails, 3 meters on a side, that could tuck inside a nanosatellite. The first NanoSail-D launched in 2008 on a Falcon 1 rocket provided by the private company SpaceX, but the rocket never made it into orbit. A second option arose the next year, and the spare NanoSail-D launched successfully in November 2010 aboard a Minotaur rocket.



LightSail, designed by the Planetary Society, measures 5.6 meters on each side. Once launched, it will turn 90 degrees twice every 90 minutes as it circles Earth.

But then disaster struck. NanoSail-D didn't emerge and unfurl when it was supposed to. Mission managers had given it up as lost when in January the sail apparently decided to deploy itself on its own schedule. "Somehow it freed itself," says Alhorn. "We all have theories of what stuck it and why it came loose, but there's no conclusive evidence."

NanoSail-D unfurled itself and since then has been orbiting Earth, the first solar sail NASA has deployed in space. The craft is drifting gradually lower in altitude, and Alhorn estimates it will burn up sometime before next January.

Ordinarily, putting a solar sail into Earth orbit is harder than sending one to interplanetary space, simply because the sail has to keep readjusting its trajectory. Although NanoSail-D has succeeded in showing how a solar sail would deploy, it isn't actually controlling its position. Because it may be tumbling along under atmospheric drag instead of solar radiation pressure, some purists insist it isn't a true solar sail. Alhorn is now working on a concept for a larger sail with a novel kind of attitude control, which sets the sail's orientation with panels feathered up to 90 degrees.

Closest in concept to the original grand dreams about solar sailing, yet freighted with the memory of a recent failure, is the LightSail project of the Planetary Society. Friedman, its architect, has seen pretty much everything in the world of solar sailing; he worked on the original Halley proposal in the 1970s and spearheaded the society's drive to fly a privately funded

Up, up and away A number of solar sail projects are planned to follow the recently launched IKAROS and NanoSail-D missions. While the more expensive missions better capture the grandeur of solar sailing, other projects are getting to space quicker with cheaper approaches.

	IKAROS	NanoSail-D	LightSail-1	CubeSail	Cube Sail	Gossamer-1
Size	14x14 meters	3x3 meters	5.6x5.6 meters	5x5 meters	79mm x 250m	5x5 meters
Builder	Japan Aerospace Exploration Agency	NASA	The Planetary Society	University of Surrey/EADS Astrium	CU Aerospace/ University of Illinois at Urbana-Champaign	German Aerospace Center/European Space Agency
Cost	$15–20 million	$250,000	$2.5 million	Less than $500,000*	$3.5 million	Not available
Launch date	2010	2010	2012	2012	2013	2014
Destination	Interplanetary, past Venus	650 km Earth orbit, now dropping	825 km Earth orbit	700 km Earth orbit	700 km Earth orbit	320 km Earth orbit

*Does not include launch

sail in the early 2000s. That effort, paid for mainly by an entertainment company led by Carl Sagan's widow, ended with a splash in 2005 when the Russian rocket it was supposed to ride from a nuclear submarine failed to reach orbit.

After licking his wounds, Friedman decided to work with NanoSail-D in its initial stages. That restored his enthusiasm and inspired LightSail. "We got so interested in the design that we said we'll go further: We'll instrument the craft and build in attitude control and a telemetry system," says Friedman. Thanks to CubeSats, the sail could be built for less money than the society's last, failed attempt.

LightSail's design calls for the main CubeSat bus to unfold four rectangles covered with solar panels, then unfurl blades of Mylar film to form a kite 5.6 meters on a side. It will have cameras to photograph itself, accelerometers to measure solar pressure and a motor to help keep it pointed on course. As it goes around the Earth, the sail will have to turn 90 degrees twice every 90 minutes.

And this time, just in case, the society is building two copies: Twin LightSails are in the final stages of construction at Stellar Exploration in San Luis Obispo, Calif.

Finding a ride is next. To get above 825 kilometers in altitude, where solar radiation pressure begins to dominate over atmospheric drag, LightSail needs a launch vehicle that goes higher than most CubeSat launches. The project is now waiting for that lift, Friedman says.

Never one to give up dreaming, Friedman envisions two other LightSails to come. LightSail-2 would aim to do a longer flight in a higher Earth orbit, and LightSail-3 would fly to the gravitationally stable L1 Lagrangian point between the Earth and sun.

Future seas

Over the next few years, a handful of other solar sails under development may see the light of space, each proving in its own way that sailing on sunshine is possible. In England, a consortium from the University of Surrey and its industry partner Astrium is building two prototypes for yet another CubeSat-based solar sail 5 meters on a side, called CubeSail. Engineers have constructed one sail that relies on booms of metal tape that unroll like party poppers, and a second that uses rigid carbon fiber booms that unfold directly. The team will test both in the laboratory and by December decide which design to fly, says project leader Vaios Lappas of the University of Surrey. He expects CubeSail to launch in early 2012.

Lappas' team is also working on a larger European Union–funded project, called DEORBIT SAIL, for launch in 2014, and an inflatable sail for launch that year or the next. As its name suggests, DEORBIT SAIL's main objective is to get decommissioned space junk out of orbit. Though garbage cleanup may sound like a pedestrian task for a glorious solar sail, such applications may be what gets sails built and flown in the years to come, Lappas says. Tens of thousands of large pieces of spent rockets and other trash drift dangerously in low-Earth orbit, threatening collisions with pricey working satellites. Some countries are beginning to require spacecraft designers to install a way to deorbit satellites after their useful life has ended.

One cheap and lightweight way would be to stick a solar sail on board, which could unfurl at the end of the mission and gently guide the craft down to incineration. Or a sail could go pick up the trash directly: "We want to develop a system where we can take our deorbiting system to pieces of space debris, dock with them and bring them to the atmosphere and let them burn up," Lappas says.

JUHA PERÄSAAR/SEINÄJOKI, FINLAND

NanoSail-D, shown over Finland in February, can be seen streaking across the sky as it gradually falls out of orbit.

Yet another approach to solar sails is taking shape in a clean room in an Illinois laboratory. Researchers there have designed a sail that would unfurl from bobbins into a giant space ribbon 250 meters long, says Victoria Coverstone, an aerospace engineer at the University of Illinois at Urbana-Champaign. This project, also dubbed Cube Sail, is basically ready to fly, she says, if the team can find money for a launch and to upgrade the Mylar film that makes up the sail. The Illinois group next aims to test a spinning deployment of sail blades, on the way to an ambitiously large spinning sail whose rotating blades could measure up to 5 or even 10 kilometers long.

Meanwhile, the German space agency DLR and the European Space Agency are planning their own series of solar sails dubbed Gossamer. The first of these would launch a 25-square-meter sail into Earth orbit in 2014, followed by bigger ones over the next several years.

How all these new projects come together may shape the future of solar sailing for decades. "I think there's a lot that will happen in the next two to three years that could essentially define how solar sails take off from Earth and go into space," Lappas says.

In the longer term, solar sails will move forward only if the scientific community promotes them for missions where no other propulsion technology can do the job, says Colin McInnes, director of the Advanced Space Concepts Laboratory at the University of Strathclyde in Glasgow, Scotland. It may seem a practical end to a romantic concept, but "in the long term that's how it's going to advance," he says. "The advocates of solar sailing have to identify what the really compelling science or operational missions are where solar sailing outcompetes other propulsion technologies. It's not going to advance just because it's such a neat idea." ■

Explore more

- IKAROS: bit.ly/28yGED
- NanoSail-D: 1.usa.gov/qgNF8Z

Helping bats hold on

Scientists seek a savior as a deadly fungal pandemic explodes through vulnerable colonies

By Janet Raloff

When Donald McAlpine and his colleagues broke through a snow barricade at the entrance to a cave in New Brunswick this March, bat carcasses covered the floor. The biologists had been conducting winter surveys throughout the Canadian province for two years, monitoring the health of hibernating bats. As of early winter, all appeared healthy. But now hosts of corpses lay shrouded in a pale fungus.

Dreaded white-nose syndrome — a virulent fungal infection — had clearly arrived.

McAlpine's team, from the New Brunswick Museum in St. John, estimated that 1,200 of the cave's 6,000 bats were dead. Within a month after the discovery, the body count mushroomed to more than 5,000 among this, the province's largest known collection of hibernating bats.

The researchers immediately alerted the Canadian Cooperative Wildlife Health Centre, which sent out word asking scientists and the public throughout eastern Canada to watch for bats that were dead or acting unusual, such as flying during the day. Hugh Broders of Saint Mary's University in Halifax, Nova Scotia, also found dead bats this spring, sending them to the health center's office on Prince Edward Island. There, a pathologist confirmed that white-nose syndrome had officially reached Nova Scotia as well.

This year's Canadian cases mark the northernmost expansion of the syndrome. In the five years since the

A fungus responsible for white-nose syndrome (visible on the nose of this bat) is killing bats in eastern North America.

A. HICKS, NYS DEPT. OF ENVIRONMENTAL CONSERVATION

disease first arrived in caves near Albany, N.Y., it has spread to more than 190 sites in 16 eastern states — with suspected cases in two more, west of the Mississippi — and to four Canadian provinces. The disease's toll now exceeds well over 1 million bats.

It's "the most devastating wildlife disease in recorded history," says biologist Thomas Kunz of Boston University.

Because species affected by the syndrome are all insect-eaters, their loss could foster the transmission of pest-borne diseases in forests, croplands and among people, Gabriela Chavarria of the U.S. Fish & Wildlife Service said in testimony June 24 before a U.S. House of Representatives subcommittee. A million bats can eradicate 3.6 metric tons of insects per night, she reported. Others at the hearing cited estimates of bats' annual pest-control benefits to agriculture alone at up to $53 billion.

But scientists aren't just documenting the disease's spread and potential devastation. Teams are now testing antifungal therapies and looking for lifestyle habits that might limit vulnerability. Several scientists have begun actively investigating why the fungus is killing bats in North America — while the same infection has left European counterparts virtually unharmed. Such research might help scientists target protection efforts.

Out of nowhere

The epidemic hit during the winter of 2005 to 2006. "But we didn't know it at the time," says Alan Hicks of the New York State Department of Environmental Conservation in Albany.

A year later, biologists stumbled upon caves harboring thousands of dead and dying bats. Affected animals tended to host a characteristic white dusting of fungal hyphae, extremely friable threadlike growths. As word of the mystery epidemic spread in early 2007, a photographer realized he had loads of pictures that he had taken a year earlier at a now-ravaged site near Albany. One photo from February 16, 2006, showed nascent evidence of the fungus.

Hoping to identify this pathogen, Hicks and others immediately began circulating pictures of affected animals among researchers — "people who collectively have probably looked at tens of millions of bats," Hicks says. "And to a person, they all said: 'I've never seen anything like this.'"

Two years later, David Blehert of the U.S. Geological Survey's National Wildlife Health Center in Madison, Wis., and colleagues published data confirming that this fungus — a member of the soil-dwelling *Geomyces* — was new to science.

For its devastating impact, it would be named *G. destructans*. Unlike related fungi, this one doesn't target the dead. Instead, *G. destructans* latches onto living bats in the dead of winter.

Bats living where the weather gets cold either migrate or wait the winter out by hibernating in underground caverns and mines, often at temperatures within 1 to 10 degrees Celsius of freezing. As body temperatures plummet and immune systems take a winter break, these animals congregate in closely packed masses of hundreds or thousands. Biologists refer to the congregation locales as hibernacula. And it's in these chilly chambers that the cold-loving *G. destructans* finds its hosts.

A mine that for ages served as New York's largest hibernaculum used to host more than 200,000 bats. Once white-nose struck, the resident population plummeted to 2,000 within just three years. Much of the die-off involved one species, the little brown bat, *Myotis lucifugus*.

Many different types of bats can share a hibernaculum, and biologists are now studying whether the little brown's hibernation preferences match the narrow temperature and moisture range most favored by *G. destructans*. The findings might explain why little browns — long the most common bat in the eastern United States — often suffer 90 percent or higher mortality within a year or two of white-nose arriving at their hibernacula.

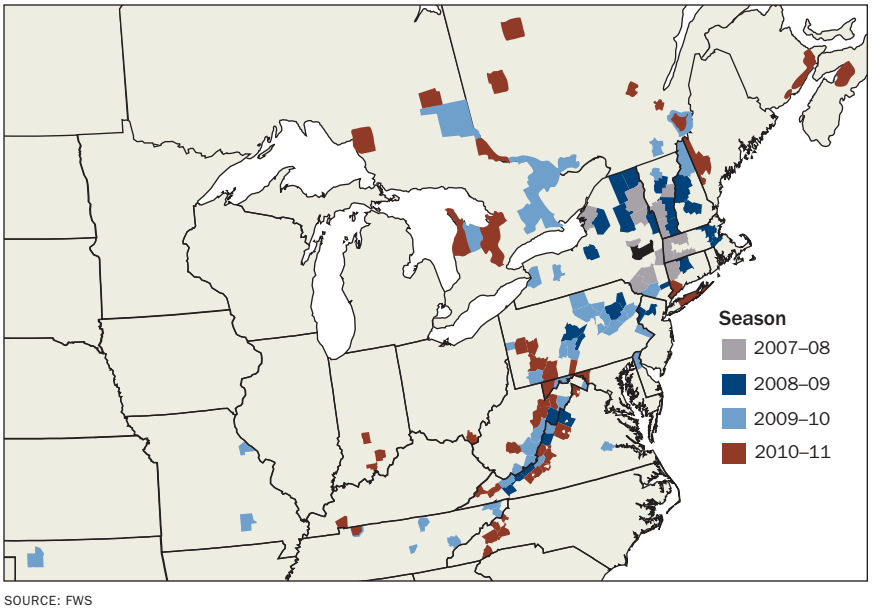
Across North America, little browns have taken the biggest hit in terms of overall numbers, but at least five other species on the continent have also been devastated by white-nose.

White-nose misnomer

The syndrome gets its name from the observation that infected bats often develop a thin mask of pale fungal fibers on their faces. "If you touch it, the fungus

Fungal surprise After first being identified in a bat colony near Albany, N.Y., in 2007 (locale shown in black), a white fungus has since spread to caves across the eastern United States and into Canada. Three cases are suspected in two states west of the Mississippi River.

Counties with confirmed or suspected white-nose cases



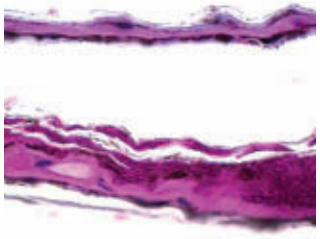
SOURCE: FWS

VECTORAPZ, ADAPTED BY E. FELICIANO

falls apart," Hicks says. Any disturbance will make it visually disappear. But it's not truly gone.

Smooth white patches may also form on the ears, tail, feet or wings, which recent work shows are most vulnerable. Researchers are now coming to realize that a more apt name for this epidemic might be wing-digesting syndrome.

This fungus doesn't invade blood vessels and spread the way other fungal species do, explains wildlife pathologist Carol Meteyer, also of the USGS health center in Madison. *G. destructans* initially starts multiplying on the skin of wings, then shoots hyphae — essentially the body of the fungus — out in all directions, she, Blehert and colleagues reported last year in *BMC Biology*.



In white-nose syndrome, a bat's normally healthy wing tissue (top band) gets replaced by dark and bubbly fungal cells (bottom band).

"My assumption is these hyphae are releasing biologically active enzymes because they digest the skin," Meteyer says. Instead of creating open, oozing sores, the fungi fill in behind the eroding skin. What's left is a wing with fungal cells increasingly substituting for bat cells.

With a bat's immunity depressed during hibernation, white-nose syndrome doesn't elicit redness, swelling or irritation. Only when an animal wakes and its body temperature increases can it begin to fight the fungus. By then it's usually too late.

Though most bats wake periodically throughout the winter, bats infected with white-nose may rouse more often and for a longer time than noninfected bats. Researchers at USGS's Madison center note that frequent and somewhat prolonged arousals by infected bats also tend to coincide with emaciation and attempts by the animals to slake their thirst. The team now suspects that fungal digestion of wing tissue underlies both symptoms.

Wings make up about 85 percent of the total skin surface of a bat's body, Blehert notes. Skin on the wing not only plays a role in blood pressure regulation and gas exchange, he says, but also water balance. As wing infections progress, a developing thirst is likely to rouse bats. Waking pushes body temperature up to normal and puts a big drain on a bat's stores of energy — fat.

Not surprisingly, awake, infected bats tend to be weak and hungry. McAlpine says some bats at the infected cave he visited were so famished that they left in search of food. But because it was still March, there were no insects to eat. "These bats were essentially dead on the wing," he says. He encountered several that traveled too far in their fruitless search for food; they froze to death.

To evaluate white-nose's effects on rousing under controlled conditions, Craig Willis of the University of Winnipeg in Manitoba and his colleagues have monitored a colony of several dozen infected little brown bats in the lab. His team installed sensors to keep track of the animals' body temperatures and video cameras to record when animals rouse, and whether they show signs of excessive thirst. The team is now analyzing the video footage to get a better sense of the devastating chain of events that the fungus appears to trigger.

Despite the damaging effect in American bat colonies, *G. destructans*–infected European bats aren't dying, an international team of scientists reported April 27 in *PLoS ONE*. Jeff Foster of Northern Arizona University in Flagstaff and others are now investigating why.

Foster is sequencing the genome of *G. destructans* from seven sites in the United States and Canada and four in Europe. Although fungi from the two continents are relatively closely related, preliminary findings show that there is far less variation in genes within the North American samples. That find is precisely what he would expect if the American samples derive from a common immigrant that had been established elsewhere for a long time — such as in Europe.

Last year, researchers at the Broad Institute in Cambridge, Mass., completed a more thorough analysis of the U.S. variant's genome. This July, they finished cataloging the individual genes contained in the fungal DNA and predicted what proteins the genes make, says team leader Christina Cuomo. Over the coming year, her group will compare these proteins with those produced by different fungal species (her team has already sequenced genomes for more than 50 fungi, none of which affect bats). Any proteins unique to *G. destructans* could shed light on how the pathogen kills, Cuomo says, and how it might be killed.

But Willis isn't waiting. This past winter his group began directly investigating the relative toxicity of *G. destructans* from each continent in Canadian bats collected from a syndrome-free cave. The researchers infected 18 bats with the American strain, 18 more with its European cousin and left a third batch untreated. If each fungal variant causes comparable disease, then some special vulnerability of North

European bats appear resistant to white-nose syndrome, a clue that may help fight the spread of the fungus that causes it. A European bat with signs of the fungus (left) was able — with a little grooming — to clear the infection in nine days (right).

FROM TOP: C.U. METEYER/USGS; S.J. PUECHMAILLE *ET AL*./*PLOS ONE* 2011

American bats would explain the continent's pandemic, Willis says. His team expects to publish its findings soon.

Best case is slow recovery

In the meantime, scientists are anxious to find a treatment. Plenty of medicines for fungal infections in people can kill *G. destructans* — at least in the test tube, notes Alison Robbins of the Cummings School of Veterinary Medicine at Tufts University in North Grafton, Mass. That knowledge has led her and others to investigate the potential of terbinafine, an active ingredient in many athlete's foot medicines, to treat white-nose syndrome. This drug has been used safely in children around the world, she notes.

Last year, she dabbed it on bats that were temporarily taken from roosting in a hibernaculum. "But just the disturbance of doing that killed them," Robbins says. So she and bat physiologist DeeAnn Reeder of Bucknell University in Lewisburg, Pa., turned to lab studies, applying terbinafine onto wings of infected bats as a cream or spray. It didn't save them.

Robbins also tried injecting terbinafine directly into white-nose-infected little brown bats that she brought back to her lab from a cave in Virginia. All bats that were handled and kept warm following the disruption, whether treated or not, survived longer than those that went straight back into hibernation without any care from Robbins' team. But none survived hibernation more than roughly 100 days, Robbins says. Few made it even that long. The stress, especially from handling, was enough to kill them. Still, she says, she hasn't given up on terbinafine.

The bats' 600-kilometer road trip to Massachusetts probably contributed to their stress. Unfortunately, Robbins says, the Virginia colony was the closest of any significant size. As recently as 2008, some 10,000 bats used to hibernate about 50 kilometers from her facility. By 2009, the syndrome had culled that population to 117. This past fall, just 14 bats returned.

Insect-eating bats simply don't do well in captivity, Robbins says, but scientists may need to keep small numbers alive in the lab until a workable treatment can be found. "We have to try to figure out how to make it work," she says. "At this point, there's nothing to lose."

USGS

Scientists documenting white-nose syndrome's spread often have to climb through caves and abandoned mines over piles of dead bats.

Kunz has been focusing on another survival strategy: making bats' summer digs more hospitable.

In spring, hibernating females awake and take flight to maternity colonies. These sites can be the ridgepoles of barns, somebody's attic or a natural site. In contrast to winter, when they hunker down in near-freezing accommodations, females seek ultrawarm homes in summer where they nestle together, conserving their bodies' energy for pregnancy and lactation. But as white-nose has taken its toll, Northeastern maternity populations have plummeted. This June, Kunz visited a trio of summer lodges that used to host between 800 and 1,200 bats each. Two were empty and the last housed just 38.

Concerned that some communities are losing too many bodies to maintain crucial spring warmth, his group designed what it calls roost modules. Outfitted with oodles of baffles, these wooden structures can be inserted into buildings, creating bat incubators. He has installed them at two sites. Unlike neighboring populations that continued to dwindle perilously, colonies with roost modules seem to have stabilized at 30 percent of the original colony size, Kunz says. "I'm now collecting data on genetic variation in the survivors to see if they show signs of genetic resistance."

Because effective treatments for the disease are lacking, some scientists have pinned their hopes on the evolution of such resistance among American bats. Biologist Sébastien Puechmaille of University College Dublin suspects European bats have already evolved such a resistance, explaining their survival. "It appears the fungus has been in Europe for a long time. And when I say a long time, I mean thousands — if not tens of thousands — of years," he says.

But there is growing concern that the initial waves of infection won't leave enough survivors to successfully breed and reproduce, jeopardizing the chance of building a more resistant population, says ecologist Winifred Frick of the University of California, Santa Cruz. Although bats mate in the fall, a female doesn't ovulate and become pregnant until the following spring, and then only if she is fat and healthy enough to support a pup.

With infected bats now emerging from hibernation emaciated, dehydrated and with damaged wings, their bodies are prioritizing allocation of their energy into getting well, Kunz says. That means, even with the help of roost modules for warmth, reproduction could be put on hold at precisely the time more bats with the survivors' genes are needed to begin rebuilding savaged populations. Any recovery of American populations from white-nose syndrome, scientists now suspect, will take many decades if not a century or longer.

For the scientists, that means there's no end in sight for what has turned out to be exhausting, daunting and ultimately disheartening work.

Often, Reeder says, "we have to drag ourselves on hands and knees through small spots in caves, crawling on bat carcasses. It feels like we're working ourselves to the bone — just to document an extinction." ■

Explore more

- USGS white-nose site: www.nwhc.usgs.gov/disease_information/white-nose_syndrome/

Bypass's big boon

Scientists spot key players in surgery's surprising ability to reverse diabetes

By Nathan Seppa

Just in time to combat the obesity epidemic sweeping the United States, a surgery called gastric bypass is riding a host of molecular and clinical findings to emerge as the preferred operation for severely overweight people. There is no shortage of patients; fully one-third of U.S. adults are now obese.

Gastric bypass has gained popularity in part because it takes the pounds off. The operation leaves the stomach smaller, meaning a patient gets full faster, eats less and loses weight at a steady pace. Other common obesity surgeries have those effects too, but gastric bypass also reverses type 2 diabetes in most people, an outcome that bordered on alchemy when first noticed years ago.

New research clarifies the molecular players that make this medical sleight of hand possible, as well as revealing other potential payoffs of the digestive changes — less heart disease, fewer breathing problems and lower blood pressure.

Electing to have major surgery is a tough call; gastric bypass doesn't always succeed. Patients can backslide, regaining lost weight. And about 10 percent of the surgeries have complications that can result in infections, blood clots or the need for repeat surgery.

In the United States, up to 70 percent of people who get elective weight-loss surgery go with gastric bypass.

But many who witness the effects of gastric bypass firsthand suggest that the hard evidence has now tipped the scales in favor of the operation.

"Everything we do in medicine is a risk-and-benefit assessment," says Guilherme Campos, a surgeon at the University of Wisconsin–Madison. For

NICOLLE RAGER FULLER

very obese patients, he says, "the gauge is whether the risk of the present condition may be higher than the risk from the surgery itself. We think the risk of the condition is higher."

Going all in

Like poker players pushing their chips into the center of the table, up to 70 percent of people in the United States who elect to have weight-loss surgery now go with gastric bypass. It's a permanent change that diverts food around much of the stomach and the upper portion of the small intestine. Bypass surgery far outpaces gastric banding, a reversible operation that is the second most popular choice at about 20 percent. Other options exist but are much less common.

"I think gastric bypass will continue to be the mainstay of procedures because we understand how it works now," says Robin Blackstone, a surgeon and president of the American Society for Metabolic and Bariatric Surgery who practices at the Scottsdale Healthcare Bariatric Center in Arizona. "It's hitting obesity on so many fronts."

The foremost front is food intake. Patients benefit not only from a smaller stomach, but also from chemical changes that occur as a result of the gastric switcheroo. Bypass surgery quells appetite by knocking back a hunger hormone called ghrelin, which is normally secreted by the stomach lining in response to food. And levels of an appetite stopper called peptide YY have been shown to increase five times as much in response to food among gastric bypass patients compared with levels in people who didn't get the surgery. A Columbia University team reported last year in the *Journal of Clinical Endocrinology & Metabolism* that levels of a digestive hormone and appetite inhibitor called oxyntomodulin are doubled in diabetic gastric bypass patients only one month after surgery, whereas similarly obese people who lost weight by dieting saw no increase.

Hormonal switch flipping also appears to give bypass its power against type 2 diabetes, the adult onset kind.

When a person eats, the pancreas cranks out insulin — the hormone that regulates how cells burn sugars for energy. Patients with type 2 diabetes typically make insulin, but their cells resist its effects and leave too much sugar circulating in the blood.

Within weeks of gastric bypass, insulin resistance disappears in most patients, says John D. Scott, a surgeon at the Greenville Hospital System University Medical Center in South Carolina. "Gastric bypass surgery kind of jump-starts that whole process," he says.

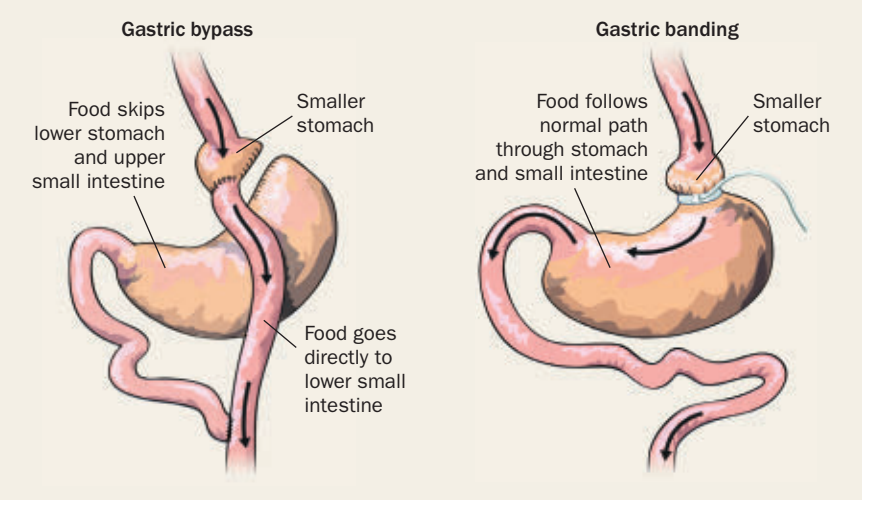
In 2006, a research team at the Hospital Clínic Universitari in Barcelona established that only six weeks after gastric bypass surgery, patients (while still obese) make substantially more of the hormone glucagon-like peptide 1 in response to a meal than they did before having the operation. Shuttling food directly to the middle portion of the small intestine boosts GLP-1, which keeps insulin-making cells alive, delays carbohydrate absorption and boosts insulin supplies as needed — roles that many scientists believe are instrumental in knocking back insulin resistance.

While GLP-1 may do much of the diabetes-reversing job, more recent studies suggest that it has helpers. A 2008 study from researchers at East Carolina University in Greenville, N.C., found that gastric bypass patients have a decrease during the first year after surgery in a compound called IKK-beta, which is known to sabotage insulin signaling. Increases in growth hormone seen within six months of gastric bypass surgery coincided with improved insulin sensitivity. And changes in a gut hormone called glucose-dependent insulinotropic polypeptide also seem to contribute to diabetes reversal.

By skirting the lower stomach and upper small intestine, the surgery reduces the amount of sugars being absorbed from meals, lessening the blood sugar levels that the body must handle. The drop in calories throws the body into what scientists call "negative energy balance." That may help to regulate glucose metabolism and stop diabetes in its tracks, scientists at Catholic University in Rome reported in a 2009 analysis in *Diabetes & Metabolism*.

Such changes may extend to some of the body's most basic biology. In April, members of the Columbia team and their colleagues reported in *Science Translational Medicine* that gastric bypass patients who had lost 20 pounds showed a dramatic decrease in blood levels of certain amino acids, the building blocks of proteins. This effect didn't occur in a group of obese people who had lost 20 pounds by dieting. In studies

Top two Gastric bypass redirects food around most of the stomach and the upper small intestine. Gastric banding, the next most popular weight-loss surgery, places a band around the stomach to limit its size. Bypass' strengths come from hormonal switches flipped by diverted food.



NICOLLE RAGER FULLER

of animals on high-fat diets, high amino acid levels in the blood have been linked to insulin resistance.

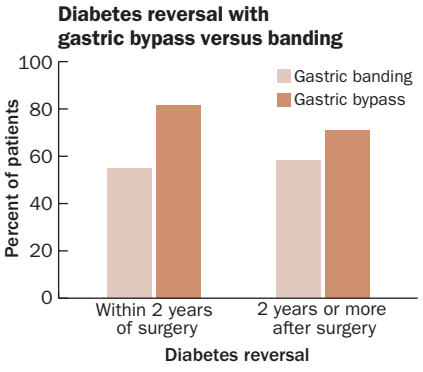
Taken together, these biological effects seem to give gastric bypass an edge over stomach banding — in which doctors insert an adjustable band around the stomach, constricting it and limiting how much it can hold at any time. Banding makes a person feel full faster, and the operation succeeds in many people because they eat less. But because the food still takes its normal path through the digestive system, banding doesn't trip hormonal switches the way gastric bypass does, says Edward Mason of the University of Iowa in Iowa City, who pioneered gastric bypass surgery for obesity in the 1960s.

Other studies have proved bypass's mettle by pitting it directly against banding. A Swedish study of more than 2,000 obese people who underwent surgery found that after 10 years, gastric bypass patients had lost 25 percent of their body weight, on average, compared with 14 percent among banding patients. The researchers reported the findings in the *New England Journal of Medicine* in 2007.

Bypass's diabetes-busting ability has also proved superior. Campos, while at the University of California, San Francisco, found that type 2 diabetes disappeared in three-fourths of gastric bypass patients but in only half of those getting banding. That report appeared in the February *Archives of Surgery*.

And the benefits of bypass aren't limited to diabetes. The procedure decreases a person's risk of heart attack by about half, Scott reported in June in Orlando at a meeting of the American Society for Metabolic and Bariatric Surgery. Isaac Samuel of the University of Iowa reported at the same meeting that of 81 migraine sufferers who underwent gastric bypass, 57 had complete resolution of their migraines after at least a year. Fifteen others had partial improvement. These findings complement previous studies showing that high blood pressure falls among bypass patients and that bypass eliminates or improves sleep apnea — a breathing disorder linked to long-term health problems — in about 90 percent of patients.

Diabetes switch Gastric bypass outcompetes gastric banding when it comes to reversing type 2 diabetes.



SOURCE: H. BUCHWALD *ET AL/AM. JOURNAL OF MED.* 2009

Pulling back

To confer such benefits, though, gastric bypass must be done well. It's a tricky surgery that is difficult to master. Scott says that success rates have risen in recent decades with the development of a more experienced cadre of surgeons, hospital support teams devoted to the patients and the advent of laparoscopy — in which the operation is performed using a series of fingernail-sized incisions.

But the surgery still carries risks, with most severe problems occurring soon after the operation. The risk of dying within a month of gastric bypass surgery, primarily from complications, is around 2 per 1,000 patients in centers that do a lot of obesity surgery, data from the American Society for Metabolic and Bariatric Surgery show.

"That's about the same risk as a hip replacement," says John Morton, a surgeon at Stanford University School of Medicine.

Gastric bypass patients risk bloating and nausea if they eat too much or wash a meal down with too much fluid. Bypass also ushers alcohol into the bloodstream rapidly. In May in Chicago, researchers from the Karolinska Institute in Stockholm reported at Digestive Disease Week that blood alcohol levels spike faster and take longer to come down in gastric bypass patients than in others, suggesting an increased risk of alcohol abuse. And studies by Morton have shown that a 5-ounce glass of red wine runs up blood-alcohol levels in these patients to nearly 0.09 percent, over the legal limit.

Stomach banding carries less surgical risk and no added alcohol danger. But it can exacerbate heartburn, and more banding patients need repeat surgery than bypass patients.

Campos thinks gastric bypass outweighs other surgical options in most cases, but he also says that for severely obese patients any weight-loss surgery "is a better option than no surgery." Though 200,000 to 250,000 people get some form of obesity surgery each year in the United States, some estimates suggest that about 15 million would benefit from it.

Many insurance companies cover obesity surgery. Afterward, a patient requires less medication for diabetes and high blood pressure, says surgeon Henry Buchwald of the University of Minnesota. He and colleagues reported in 2008 in the *American Journal of Managed Care* that laparoscopic weight-loss surgery had a payback time of just two years.

But many employers don't include the surgeries in plans covering workers. Buchwald says some people still don't view obesity as a life-threatening condition. "Employers might say, 'It's cheaper if we don't cover obesity surgery,'" he says. "But they wouldn't say, 'We can get a better deal by not covering cancer of the colon.'"

Others think obesity is something that can be fixed without surgery, that all a person needs is willpower. But the truth is, most dieting attempts fail.

"The story of our patients is a lifetime of trying," Buchwald says. Although success stories on TV dieting shows may be heartening to watch, there are millions of severely obese people in the United States for whom dieting hasn't worked. Ultimately, they are the biggest losers in the obesity epidemic. ■

Explore more

- Mayo Clinic's gastric bypass page: www.mayoclinic.com/health/gastric-bypass/MY00825

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The Neighborhood Project: Using Evolution to Improve My City, One Block at a Time

David Sloan Wilson

Darwin's theory of evolution is the bedrock of modern biology. Populations of organisms acquire advantageous new traits, pass them on to subsequent generations and sometimes create new species. In his fascinating new book, Wilson, an evolutionary biologist, suggests applying the principles of evolution to social and cultural problems.

In an easy-to-read, conversational style, Wilson describes how he and his colleagues and grad students use the techniques of evolutionary biology to diagnose problems in areas as diverse as childhood education, human relations, city governance and even economics.

In Binghamton, N.Y., where Wilson teaches, he and his students use statistical databases to track, neighborhood by neighborhood, various aspects of quality of life, such as prenatal and early childhood care, happiness, and high school graduation rates. Wilson's Binghamton Neighborhood Project has helped people in the community become more engaged, working to improve their parks and other shared spaces.

Human behaviors, he says, respond to selective pressures just as organisms do: Those that provide benefits to an individual or group proliferate, and those that don't, disappear. In a comparison with the animal world, Wilson says people in a community can behave more like water striders he observed on a pond, careening around in pursuit of their own goals, or more like wasps, "working together, without necessarily knowing it, for the common good."

Human cultural evolution, like its biological counterpart, boils down to a process of mutation, variation and natural selection, Wilson contends. A theory so useful for understanding the human condition must also be useful for improving it. —*Sid Perkins*

Little, Brown, 2011, 416 p., $25.99

Now You See It

Cathy N. Davidson

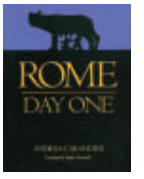
The author started out as a child with dyslexia and big-time learning problems. Now she's an out-of-the box administrator at Duke University who has written a stimulating book trumpeting the benefits of computer-based school and business reforms that exploit people's natural tendency to multitask.

Davidson's debut as a digital rabble-rouser came in 2003. She led a controversial program that gave free iPods to Duke freshmen, asking them to think up learning applications for the tiny devices and pitch them to the faculty. Students found uses for iPods in nearly every discipline, from environmental science to medicine.

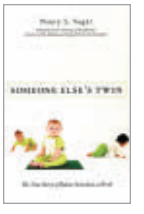
Duke's iPod experiment caused a ruckus because many people are stuck in a premillennial mindset that masks an 800-pound gorilla of a game changer in their midst, the author contends. Although Davidson veers uncomfortably close to a utopian view of the digital revolution, she makes a provocative case for radical educational and business reforms. She presents vivid examples of schools and workplaces unleashing learning and achievement.

A narrow focus on familiar practices can stifle imagination and change, but so do other factors unmentioned by Davidson. Consider the human need for certainty, father of countless rationalizations for staying on sinking ships and denying that rising waters are a problem. Still, Davidson's call to experiment with digital schemes that turn students and workers into motivated problem solvers rings as clear as a bell atop a little red schoolhouse. —*Bruce Bower*

Viking, 2011, 352 p., $27.95

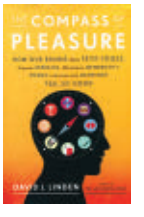


Rome: Day One
Andrea Carandini
An archaeologist puts forth a controversial theory, contending that a king named Romulus scratched out Rome's boundaries in a day. *Princeton Univ. Press, 2011, 172 p., $24.95*

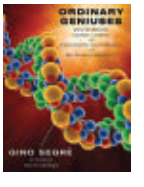


Someone Else's Twin
Nancy L. Segal
An expert on twins explores cases of identical twins raised apart after one is switched with another infant at birth, delving into the effects of nature and nurture on behavior. *Prometheus Books, 2011, 301 p., $25*

When Gadgets Betray Us
Robert Vamosi
This investigation into the dark side of the digital world reveals hidden risks of smartphones and how to manage gadgets that can expose a user's every move. *Basic Books, 2011, 222 p., $26.99*



The Compass of Pleasure
David J. Linden
A neuroscientist gives a lively description of the pursuit of pleasure, one of the most powerful forces in the human brain. *Viking, 2011, 230 p., $26.95*



Ordinary Geniuses
Gino Segrè
A biography of physicists Max Delbrück and George Gamow describes their friendship and research in cosmology and genetics. *Viking, 2011, 352 p., $27.95*

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Earthquake rumblings

I reviewed this very interesting story ("Seismologists in a rumble over quake clusters," *SN: 5/7/11, p. 5*) this morning, and it occurred to me that the connection between all of these very severe earthquakes might possibly be the change in weight distribution throughout the planet, resulting from temperature increases due to climate change with the melting of the glaciers: decreased weight where the glaciers were and increased weight of water on the ocean floors. Also, it seems as though the majority of them are clearly distributed around the rim of the Pacific Ocean (the "Ring of Fire"). **James R. Stewart Jr.,** Londonderry, N.H.

Researchers have linked melting glaciers and ice sheets to increased earthquake activity in places such as Greenland, Alaska and the Canadian Arctic. Removing overlying ice generally speeds up the slip rate along geological faults. However, there's little evidence to suggest this is a significant factor at middle and low latitudes, including most of the locations that have seen large quakes in the last few years. —Alexandra Witze

The Parkinson's bug

The story on a possible link between *Helicobacter pylori* and Parkinson's disease ("Ulcer bug may trigger Parkinson's, *SN: 6/18/11, p. 18*) was intriguing. Unfortunately, it was all mouse research. Are scientists going after human data, such as looking at the rate of Parkinson's disease in persons who have had their *Helicobacter* eradicated as an ulcer preventive? **William Check,** Evanston, Ill.

The article speculates that one way *H. pylori* might cause Parkinson's is by modifying cholesterol into a toxic form. In August 2007, *Science News* reported that a drug, simvastatin, may reduce rates of Parkinson's as well as dementias by roughly 50 percent. Might the drug produce its protective effect by either counteracting the action of *H. pylori* on cholesterol or by reducing the amount of cholesterol available to the bacteria? **Nancy Sutter Axford,** Sacramento, Calif.

Some studies in people suggest H. pylori *may play a role in Parkinson's. Scientists in England found that Parkinson's symptoms were lessened in people with the disease who had been successfully treated with antibiotics. But in patients who weren't able to kick the bacteria, symptoms worsened. Traci Testerman, one of the researchers who led the new study in mice, thinks that antibiotics may have stressed the* H. pylori *bacteria, causing them to release even more of the modified cholesterol. —Tina Hesman Saey*

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

From the Archive

For the full 1936 article with drawings, visit **www.sciencenews.org/archive_eye**

Einstein invents automatic camera with "electric eye"

Dr. Albert Einstein, the famed proponent of relativity and acknowledged leader of the science of mathematical physics, stands revealed on the records of the U.S. Patent Office as the inventor of a camera that snaps photographs with the proper aperture and exposure automatically determined.

He has applied the photoelectric cells or "electric eye" to cameras. Experts reading the patent specifications foresee the possibility that the invention will be practically and commercially important in the next few years.

The patent is No. 2,058,562 and the application was filed on Dec. 11, 1935, by Dr. Einstein jointly with Dr. Gustav Bucky of New York City.

This is the way the Bucky-Einstein camera works: Light from the scene or object being photographed comes into an auxiliary lens and falls on the photoelectric cell. There is a screen of varying transparency mounted in the main camera lens system that is moved in accord with the amount of light that the electric eye sees, letting more light fall on the photographic plate when necessary.

So far as can be judged, abstruse mathematical theory was not needed in designing the patented camera but Einstein's genius probably contributed largely to making it operate correctly.

Most autoexposure cameras use a different mechanism from the one proposed by Einstein and Gustav Bucky.

CAMERA: SCIENCE & SOCIETY PICTURE LIBRARY/GETTY IMAGES; PAPER: PAPHIA/ISTOCKPHOTO

UPDATE

An inventor behind the genius

It should come as no surprise that Albert Einstein, known for revolutionizing physics with his theory of relativity, was also an inventor. After all, his father ran an electrical technology business, and Albert spent a lot of time working at the Swiss patent office.

Within five years of Einstein and Gustav Bucky's receiving the patent for their "light intensity self-adjusting camera," Kodak began advertising a camera called the Super Six-20, with an "electric eye" that automatically corrects exposure. Despite surface similarities between the two cameras, patent drawings show no shared underlying principle of operation. It is also unlikely that Einstein's proposed camera has much to do with the digital, pocket-sized picture-taking gadgets people use today.

His work with refrigeration in the 1920s, though, had a larger impact. During that decade he joined with the much younger Leo Szilard to develop a design for a refrigerator that wouldn't leak toxic gas from its mechanical parts. The solution: Eliminate the mechanical parts. Known as the Einstein-Szilard electromagnetic pump, the most successful design relied on an electromagnetic field to move a metallic liquid that then compressed the refrigerant. The inventors were paid well, largely because of an agreement with a German electric company.

Einstein is also credited in part with patents for gyrocompasses and a hearing aid. Perhaps his most unusual patent, an "ornamental design for a blouse," was awarded in 1936. The garment's defining quality was its side openings, which also served as armholes. Functional and fashionable, if not exactly genius. — *Elizabeth Quill*

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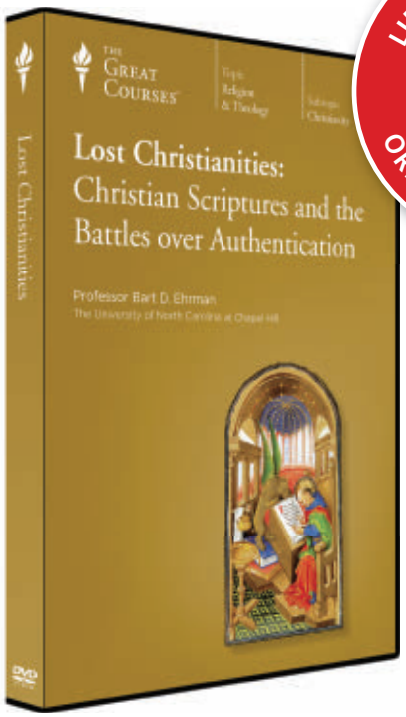

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