

Rats with Feelings | Sign of Higgs, Maybe | Dead Sea Dying

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ScienceNews

MAGAZINE OF THE SOCIETY FOR SCIENCE & THE PUBLIC ■ DECEMBER 31, 2011

20
Science News of the Year
11

Network rulers
Atom smasher shutdown
Saffron vs. cancer
No amygdala, no fear
Earth's aerosol shield
Fukushima fallout
Fluorescent felines
Skin circuitry
Polar bears' past
Polymer remolded
Stone Age paint shop
Quantum theory purified
Strong-arm chemistry
Iceman's last meal
Arctic's 'new normal'
Periodic table redo
Unlikely disease links
Speedy neutrinos
Brain stent snare
Friendly microbes
Dawn runner discovered
Lakes lurk on Europa
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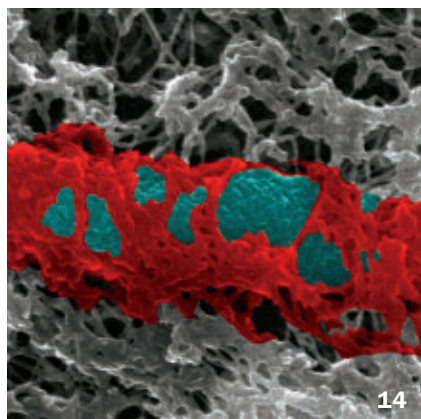
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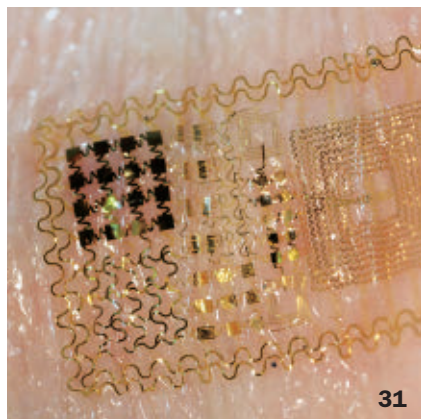
11



14



30



31

ScienceNews

In The News

5 STORY ONE

- Using electricity, scientists grow an eye in a frog's gut

8 EARTH

- Precipitation patterns influence geologic hazards
- Kilauea can get ugly
- Dead Sea went dry
- Deep-sea microbes make electric currents

10 ATOM & COSMOS

- LHC gets whiffs of Higgs
- Storm chased across Saturn
- Planet well placed for life

12 LIFE

- Early animal fossils have 200-million-year backstory

14 GENES & CELLS

- Egg timer runs faster in worms
- Cellular spiderweb catches a different kind of bug
- Pituitary gland assembles itself in a lab dish

16 BODY & BRAIN

- Rats have a heart
- Caffeine target in brain found
- Bedbugs have big families
- Vaccine works against emerging chikungunya virus
- Dengue vaccine effective against all four strains

18 MATTER & ENERGY

- Odd superconductor may hold even odder particle
- Diamonds entangled
- How ice forms at -48°C

Special Section

20 SCIENCE NEWS OF THE YEAR

COVER STORY: *Science News* editors and writers survey the top news from the world of science in 2011.

- 20 Science & Society
- 22 Atom & Cosmos
- 23 Nutrition
- 24 Molecules
- 25 Environment
- 26 Genes & Cells
- 27 Matter & Energy
- 28 Body & Brain
- 30 Life
- 31 Technology
- 32 Earth
- 33 Humans

Departments

2 FROM THE EDITOR

4 NOTEBOOK

34 BOOKSHELF

35 FEEDBACK

36 FROM THE ARCHIVE

Physicists compete in a race to the bottom with a finish line that can never be reached.



COVER Floating lanterns in Japan's Fukushima Prefecture commemorate more than 20,000 victims of the March 2011 earthquake and tsunami. *The Yomiuri Shimbun via AP Images*

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FROM THE EDITOR

Empathic rats show that science has a lot to learn



Humans have a lot to learn about rats. Or perhaps from them.

For one thing, rats don't deserve the metaphorical usage of their name to signify duplicity and deception. Nor should "rodent mentality" suggest substandard intelligence. Some rats, at least, live honorable lives and are pretty darn smart.

As Laura Sanders reports (Page 16), rats can learn some clever tricks, such as how to open a cage — not from inside, to escape, but from outside, to liberate an incarcerated fellow rat.

Curiously, rats offered the opportunity to figure out how to unlock an empty cage didn't show much aptitude for it. But motivated by the chagrin of witnessing a friend held captive, rats showed much greater success at the cage-opening task. Even when lured by another cage with a cache of tasty chocolates, half the time the rats opted to free the prisoner first.

Such experiments demolish the old notion of behaviorism, which held that rats (and people, for that matter) were little more than stimulus-response machines. Some rats are actually thinking and apparently feeling empathy for others. Which is more than can be said for some people.

New findings like these serve as reminders that science has a lot to learn, and not just about rats. Current science at its best demonstrates how the science of the past wasn't the whole story. Put another way, there's a reason why science news magazines are valuable supplements to science textbooks. While science struggles to learn new things about nature, science journalism offers a real-time report card on its progress. This issue offers a year's worth of examples (Page 20).

One of the best such examples arrived just in time to be included, showing that some of the most thoroughly studied subjects in biology still conceal surprises. Nobody has ever thought much about growing eyes on different parts of the body, for instance, because supposedly only cells in the head possessed eye-building potential. But it turns out that the potential to grow into an eye depends on the electrical potential across the membrane of a cell. If you create the right electrical conditions in tadpole cells, they will develop into frog eyes, no matter where on the body those cells are, as Tina Hesman Saey reports (Page 5).

That result suggests an entirely new avenue for growing new organs, not just eyes. Achieving success in people may be more complicated, of course, but that's just an opportunity for science to learn even more. —Tom Siegfried, Editor in Chief

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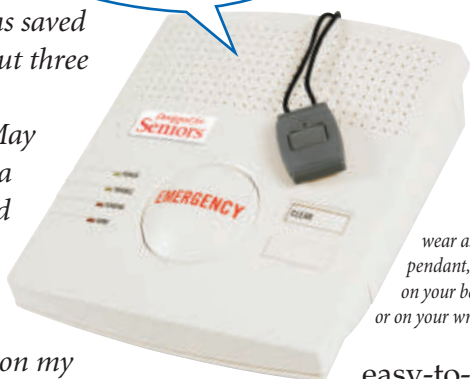
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Say What?

Vitamer \VITE-ah-mer\ *n.* One of several related chemical compounds that act as a vitamin. What is commonly known as vitamin B1—the immune system booster found in pork, legumes and brewer’s yeast—is really four different vitamers. In some cases, certain vitamers act as more potent vitamins than others. An international team has developed a new way to inventory the B1 vitamer content of alcoholic beverages. Using 204 beers picked from the 2010 Australian International Beer Awards, the scientists compared vitamer counts of lagers, ales, wheat beers, stouts and porters. Lagers scored lowest, possibly because they were pasteurized, the team reports online November 7 in the *Journal of Agricultural and Food Chemistry*. —Allison Bohac



Science Past | DECEMBER 30, 1961

EARTH AND PLANETS FORMED FROM DUST DRAWN TO SUN—The Earth and all the other planets of the solar system were formed from tiny dust particles accumulating around the sun as it passed through a vast dust cloud in space. This theory on the origin of the solar system was proposed in London by Prof. R.A. Lyttleton of Cambridge University, Cambridge, England.... The sun must have passed through several hundred if not thousands of dust clouds during its lifetime of several billion years.



During one of these encounters, the sun’s speed relative to the cloud must have slowed down to a little more than a mile a second in order to accumulate the necessary amount of dust for later planet formation.

Science Future

January 6–February 17

See five science and nature films on a 90-foot domed screen at the Science Museum of Minnesota’s Omnifest. Visit www.smm.org/omnifest

January 19

The St. Louis Science Center hosts a science café event to discuss space travel. See bit.ly/SNsttravel

February 4

The Maryland Science Center introduces a hands-on insect exhibit. See bit.ly/SNmdinsect

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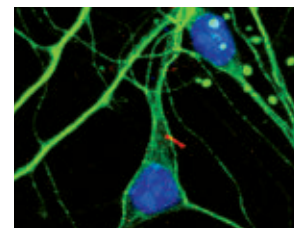
BODY & BRAIN

Some U.S. presidents go gray in four years, but they still tend to live longer than average. See “Presidency not a death sentence.”

A program in Nepal enlisting motorbike owners as emergency transport saves the lives of people bitten by snakes. Read “Scooters save lives of snakebite victims.”

GENES & CELLS

Tiny hairlike appendages on cells can sequester a protein involved in regulating appetite. Read “Cilia control eating signal.”



MOLECULES

Cosmetics and other compounds wafting off tourists’ skin threaten a masterpiece. See “Saving the *Last Supper*.”

The (-est)

Cicadas have officially been around long enough to have serenaded dinosaurs with their distinctive buzz. The newly discovered *Burmecicada protera* is the oldest definitive cicada fossil ever found, beating the previous contender by over 50 million years. Entomologists George Poinar and Gene Kritsky report in an upcoming *Historical Biology* that the amber encasing the specimen dates to the early Cretaceous, about 110 million years ago. Cicadas haven’t changed much since: *B. protera* sports forelegs shaped much like those of its modern counterparts. —Allison Bohac



Science Stats | GLOBAL QUAKE RISKS

The earthquake that struck Japan this year was unusual—at magnitude 9.0, it was one of the strongest ever recorded—but many other cities (shown, with populations) lie in active seismic zones located near faults or along the boundaries of tectonic plates.

Cities in seismic zones



SOURCE: S.A. BARTELS AND M.J. VANROOYEN/LANCET 2011

“ We will give a higher priority to those worlds that our colleagues tell us are not too warm and not too cold, but just right. ”

— JILL TARTER, PAGE 11

Earth Kilauea can kill

Atom & Cosmos Location isn't everything

Life Animal life's lost years

Genes & Cells Pituitary grows in a dish

Body & Brain Rats help each other out
Inbred bedbugs get by just fine

Matter & Energy Diamonds entangled

In the News

STORY ONE

Tiny voltage grows eyes in strange places

Fine-tuning electrical charge produces eye in frog's gut

By Tina Hesman Saey

Scientists have created a tadpole that can literally watch what it eats: The tadpole has an eye growing in its gut.

Led by developmental biologist Michael Levin of Tufts University in Medford, Mass., the researchers manipulated cells in the tadpole's gut to take on a specific electrical state. Those cells developed into a fully formed eye. Inducing just the right electrical state in cells can lead to eye growth anywhere on the body, the team reports online December 7 in *Development*.

Bizarre as the experiment sounds, it is a major step toward regenerating complex organs and limbs. One day, Levin says, someone who loses an arm or leg might be able to slip on a special sleeve that will electrically stimulate cells at the wound site to regrow the missing limb.

The study “opens up a huge door to new therapies in regenerative medicine using electricity,” says Jim Coffman, a developmental biologist at Mount Desert Island Biological Lab in Salisbury Cove, Maine.

The work is “quite a ways outside the box most developmental biologists think in,” Coffman says. These scientists usually think about specific molecules in cells building structures like eyes or limbs.



A tadpole has an eye growing in its gut (shown in red circle) thanks to scientists who manipulated electrical signals in gut cells to spark eye development. The technique might lead to technologies that spur regrowth of limbs and complex organs.

“What’s surprising is that development makes use of nonmolecular information” to create body parts, he says.

Levin’s team previously regrew a tadpole’s tail by causing cells to take in salt, which changed the electrical properties of the cells. The new eye-growing work shows that during development of an animal, electrical signals tell cells what to be when they grow up.

“Instead of a chemical factor, this is a physical factor for telling cells what to do,” Levin says.

All cells have an electrical state called a membrane potential, created when there is a different concentration of electrically charged atoms called ions outside and inside the cell. Cells have molecular gates called ion channels that can open or close to control the flow of the ions — such as sodium, potassium and calcium — across the membrane. For cells other than nerves and muscles, the

potentials created by the flows of these ions are tiny, just a few millivolts. But Levin and his colleagues have found that the voltage between cells is important for cell migration and development, and also plays a role in cancer.

In the new study, Levin’s team looked at the African clawed frog, *Xenopus laevis*. About 19 hours after fertilization of the frogs’ eggs, the membrane potentials of some cells in tadpoles’ heads drop to about –20 millivolts, the researchers found. Those cells are located exactly where eyes will later form. Injecting chemicals to block the voltage change also stopped eye formation.

That wasn’t enough to prove that electrical properties are important for eye development, though. To show that electricity can spark eye formation, Levin’s group inserted ion channels of various kinds into cells in tadpoles’ guts or tails. All of the channels could cause the same



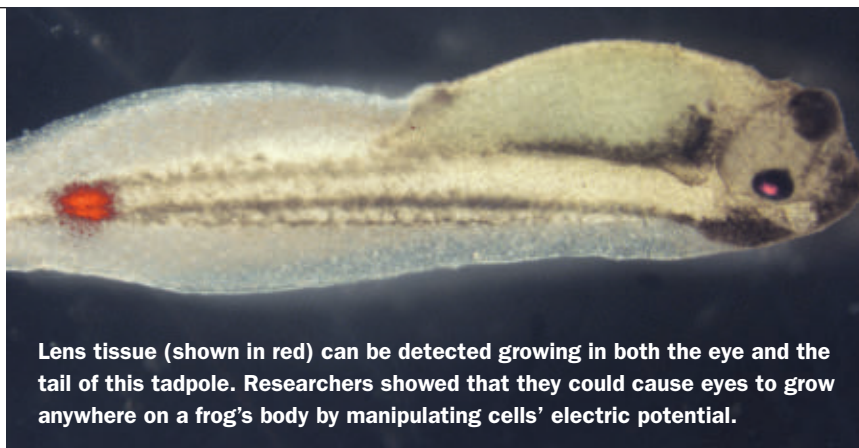
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signature voltage drop. Wherever the researchers triggered the electrical signal, eyes grew.

“What this says is there’s lots of ways to get to that membrane potential, and it doesn’t matter how you get there,” says Angie Ribera, a developmental neurobiologist at the University of Colorado Denver Anschutz Medical Campus in Aurora. She is interested in learning which channels normally cause the electrical signature and what regulates them.

Researchers previously thought that only certain cells in the head could make eyes, because inserting proteins such as the master eye regulator Pax6 into cells could cause eye growth only in the head. But the electrical signal can trigger eye development almost anywhere, indicating that the membrane potential somehow supersedes molecular information for telling a cell what to do.

Although the electrical signal is important for initiating eye formation, it does require proteins previously identified as important regulators of eye development. Somehow, dropping the cells’ membrane potential to the narrow window of voltage that triggers eye formation also turns on Pax6, which activates genes involved in making eyes. Without Pax6 the tadpoles are unable to grow eyes.



Lens tissue (shown in red) can be detected growing in both the eye and the tail of this tadpole. Researchers showed that they could cause eyes to grow anywhere on a frog’s body by manipulating cells’ electric potential.

Changing the electrical properties of cells could be a much easier way to promote regeneration than altering the ways proteins work, says Panagiotis Tsonis, a developmental molecular biologist at the University of Dayton in Ohio. “It is very intriguing and very interesting, but of course, the mechanism is not well understood.”

While Levin’s group has had success regrowing a tadpole’s tail and creating eyes where none should be in animals, Tsonis doubts electrical manipulation will work as well for coaxing stem cells in lab dishes to grow into specific organs. Development may depend upon a cell’s electrical status relative to surrounding cells, not just on reaching a particular

membrane potential, he says.

Levin’s group is working to fill in the details about how the membrane potential is generated and how it leads to eye development. He also wants to determine whether other organs have particular electrical signatures.

Biological electricity has mostly been ignored except by scientists studying nerves and muscles, but now more researchers may consider how electrical properties affect development.

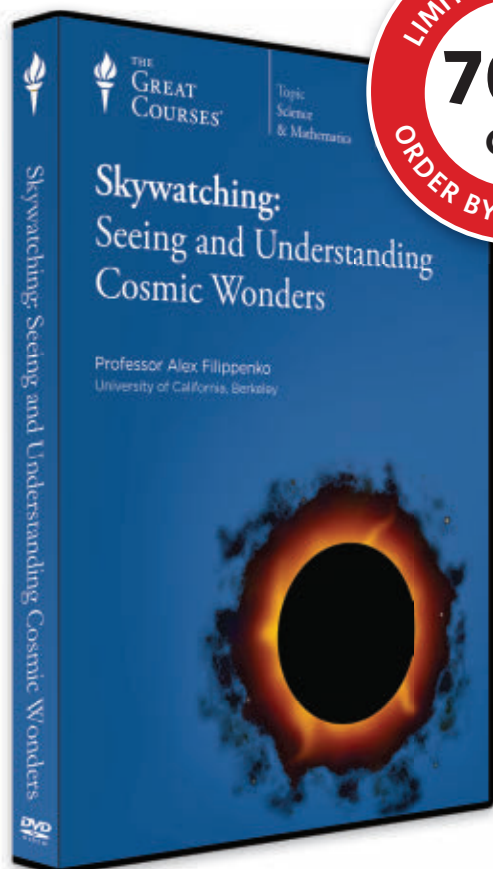
“The thing about this that is so cool is that the eye is thought of as the epitome of a complex structure,” Coffman says. “The fact that a narrow range of voltage is enough to specify an eye is kind of amazing.” ■



Back Story | A HISTORY OF REGROWTH

Michael Levin’s group is just about the only one currently investigating how bioelectricity influences development, but the field has a long history. Scientists discovered as early as 1941 that severed amphibian limbs produce current as they regenerate. That fact was rediscovered in 1977 by Richard Bogens of Purdue University and colleagues, who measured electrical currents flowing in the severed limbs of newts. Levin’s group has taken the observation to a new level and has shown that manipulating electrical properties of cells can produce strange results, such as this four-headed planarian worm. The team reported in the Jan. 28 *Cell Chemistry and Biology* that particular membrane voltages are needed to regrow severed heads on the famously regenerative flatworms, which can develop into two whole individuals after being cut in half.

FROM TOP: SHERRY AW, VAIBHAV PAI AND M. LEVIN; WENDY BEANE, NESTOR OVIEDO, PETER VALENTEK, M. LEVIN



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Earth



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Weather affects geologic activity

Rain, snow can influence timing of earthquakes, eruptions

By Devin Powell and Alexandra Witze

If you want to know the chance of an earthquake in the Himalayas or a volcanic eruption in Iceland, it may help to check a calendar. Seasonal patterns of rainfall and snowfall can affect how often quakes and volcanoes go off, scientists reported December 8.

In the Himalayas, the weight of water from monsoon rains helps dampen seismicity for a few months each year, says geophysicist Thomas Ader of Caltech. Seismic records collected from 1998 to 2004 show that the number of quakes drops in the rainy summer months and rebounds when things dry out.

Water from monsoon storms runs off the mountains and into India, where its weight bends the Earth's crust slightly. From season to season, this bending causes the surface to move back and forth, as recorded by Global Positioning System stations, in time with the rise and fall in earthquake frequency.

Calculations by Ader and his colleagues suggest that the flexing eases the stress on

the fault where two tectonic plates collide beneath the Himalayas. This change is small, less than a hundred-thousandth the stress caused by plate motions. But it lasts for months, perhaps giving the earthquakes time to slowly incubate.

"It's a very rare way of changing the stress on a fault," Ader said.

In this case, though, what goes down must come up. When the drier months come, the land rebounds, freed of its watery burden. An uptick in the number of earthquakes ushers in the winter.

In Iceland, the opposite is true: Summer is the time of greater hazard, when the country's massive ice caps slim down during the annual melt. Where that ice happens to sit atop active volcanoes, the changes can trigger eruptions below, said Fabien Albino, a geophysicist at the University of Iceland in Reykjavik.

Albino and coworkers have created computer simulations of how stress changes within rock when overlying weight is removed. Above the Icelandic volcano Katla, for instance, the ice cap is 6 meters thinner in summer than in win-

ter. This change translates to a tiny but noticeable shift in rock stress, Albino said.

Katla erupted most recently in 1918, 1955, 1999 and possibly in 2011. Each time the eruption happened between May and November. More small earthquakes also occur around Katla in summer than winter, Albino says.

In the short term, the work suggests that magma will rise within Katla—and possibly erupt—during warmer months when the stress is unloaded from above, Albino says. In the longer term, Iceland's ice has been retreating for more than a century, which means that Katla has a little bit less ice covering it every year to suppress eruptions.

In related work, Albino has studied possible links between Katla and the neighboring volcano Eyjafjallajökull, whose 2010 eruption temporarily closed European airspace. Albino's calculations suggest that the stress changes caused by Eyjafjallajökull's eruption were not enough to affect future eruptions at Katla, as some scientists had suggested.

Other factors, such as how fluid flows through the rock, still connect the two volcanoes, says geophysicist Andrew Hooper of the Delft University of Technology in the Netherlands. ■



Kilauea's explosive past

The scenic burbling lava fountains of Kilauea volcano, on the Big Island of Hawaii, belie the mountain's volatile nature. New surveys of Kilauea's lava flows show that in the last 2,500 years the volcano has been convulsed by periods of explosive volcanism, the most recent ending about 200 years ago. One eruption during that last explosive period was the most lethal ever documented at a U.S. volcano: Several hundred warriors crossing the island in November 1790 to do battle passed too close to the summit and perished in a surge of hot ash and gas. Over the last two and a half millennia, explosive periods have prevailed for about 60 percent of the time, Don Swanson of the U.S. Geological Survey's Hawaiian Volcano Observatory reported December 6. "Once these periods start, they could last for centuries," he said. On average, 5,000 people, mostly tourists, visit Kilauea daily. —Alexandra Witze

USGS

270
parts per thousand

Salinity
level of the
Dead Sea

35
parts per thousand

Average
salinity level
of the oceans

Dead Sea once turned to dust

Holy Land's salt lake ran out of water during warm spell

By Devin Powell

The Dead Sea died once. During a warm period long ago it dried up completely, new evidence reveals.

That's bad news for the lake today: It has been shrinking for decades.

"The lake may actually go dry soon," Emi Ito of the University of Minnesota in Minneapolis said December 5.

Ito and colleagues examined lake bed cores dug up by the Dead Sea Deep Drilling Project. Sediments in these cores, deposited over 200,000 years, record the history of the lake.

In theory, the supersalty Dead Sea should be protected against completely drying up; salt increases the amount of heat required to evaporate water. Computer simulations have suggested that a



The Middle East's Dead Sea, which has been shrinking for decades, may be fated to disappear completely, as it did about 120,000 years ago.

shrinking Dead Sea should eventually stabilize as it gets saltier and saltier.

But smooth pebbles buried 253 meters beneath the present-day lake bed suggest that the Dead Sea was once water-free. What's more, these stones sit atop about 45 meters of salt.

"That's how much salt we would expect if we were to take the entire Dead Sea today and evaporate it," said Steven Goldstein of Columbia University's Lamont-Doherty Earth Observatory

in Palisades, N.Y.

The researchers estimate that the lake vanished 120,000 years ago. A warmer climate at that time could have dried up the Dead Sea's water sources.

Today the Dead Sea is threatened again, this time by the diversion of water from the Jordan River for irrigation and other uses. Now fed only by mountain runoff and underwater springs, the Dead Sea dropped 10 meters between 1997 and 2008. ■

Microbes act as deep-sea battery

Organisms feed on hydrogen sulfide at hydrothermal vents

By Devin Powell

Scientists have discovered an unusual kind of battery at the bottom of the Pacific Ocean: a living one, fueled by microbes that live near hydrothermal vents.

As they munch on noxious chemicals bubbling from the seafloor, these critters create electrical currents that flow through the walls of the chimneylike structures they inhabit.

"The amount of power produced by these microbes is rather modest," said Harvard biologist and engineer Peter Girguis, who presented his research December 5. "But you could technically produce power in perpetuity."

Girguis hopes to tap this power to run

seafloor sensors. He and his colleagues measured the current by implanting an electrode in the side of an underwater chimney 2,200 meters below the surface at the Juan de Fuca Ridge off the Pacific Northwest coast.

To better understand the current's source, the researchers built an artificial chimney in the laboratory. One tube that mimicked the inside of the chimney was filled with dissolved hydrogen sulfide, which smells like rotten eggs but is palatable to vent microbes. A second tube, outside the chimney, contained only seawater.

The scientists grew a film of microbes on a piece of pyrite, a metallic mineral found in natural chimneys, that

connected the two tubes. The current the microbes produced in the pyrite increased when they were given more food, suggesting this current is how the microbes make contact with the oxygen in the seawater outside of the chimney. Pyrite seems to shunt electrons produced as the microbes break down hydrogen sulfide to these oxygen molecules, which react to form water.

Some microbes might make contact with oxygen directly in water that percolates through the pores of natural chimneys, suggests John Delaney, a marine geologist at the University of Washington in Seattle.

Girguis agrees that's possible but says it doesn't rule out his "decisive" evidence that electrical currents help the creatures to, in human terms, breathe.

"This changes the way we think about metabolism at vents," he said. ■



LHC finds tantalizing hint of Higgs

Teams report 'inconclusive' evidence for long-sought particle

By Devin Powell

The world's most powerful atom smasher has given physicists a tantalizing — but inconclusive — hint that the long-sought Higgs particle actually exists.

It's the last undiscovered elementary particle in the standard model, physicists' leading framework for describing the constituents of matter and transmitters of force. Its discovery would confirm that subatomic particles acquire their mass by interacting with a pervasive Higgs field.

Two teams at the Large Hadron Collider say they've seen showers of particles that match the debris expected when the Higgs particle breaks down.

"It's too early to tell if the success is due to the fluctuations in the background, or if it's due to something more interesting," said Fabiola Gianotti, who presented results from LHC's ATLAS detector December 13 at the European laboratory CERN, home of the LHC, near Geneva.

This subatomic detritus — seen by both ATLAS and the Compact Muon Solenoid detector at the LHC — is suggestive of a Higgs boson with a mass of about 125 billion electron volts (the mass of a proton is about 1 billion electron volts). That number corresponds with previous data from the LHC and from other colliders that have ruled out the existence of a Higgs with a mass below 114 billion electron volts or above 141 billion electron volts.

"If the Higgs was there, this is more or less the kind of thing you would expect," said Lisa Randall, a theoretical physicist at Harvard University.

The chance that the ATLAS detector's sighting is simply a random fluctuation is about one in 90. For CMS, the odds are about one in 35. That's a far cry from the gold standard needed to claim discovery: about one in 3.5 million.

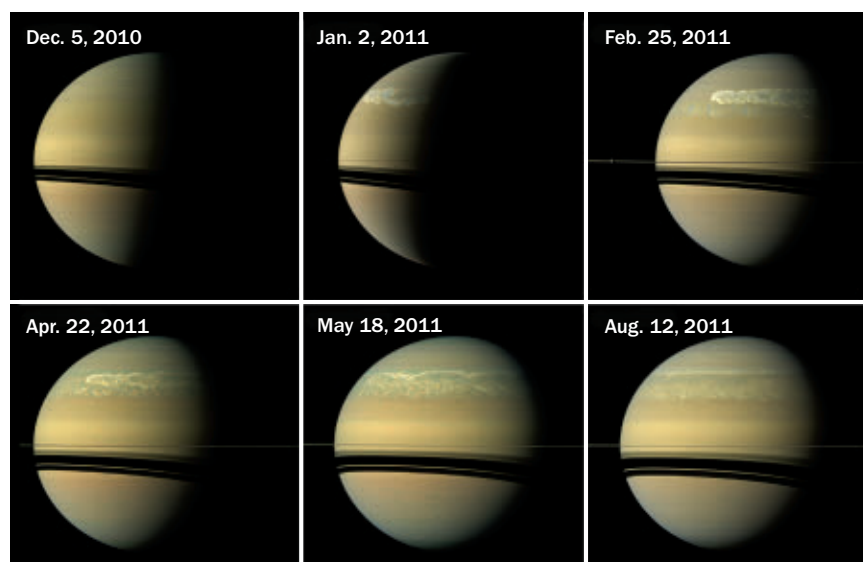
This lack of certainty is about what would be expected at this stage of the

LHC's operations. In 2011, the collider rammed together 400 trillion pairs of protons in an effort to create the Higgs particle (technically known as the Higgs boson). If the Higgs is produced in those collisions, the LHC's detectors could not see it directly. Instead, they register particles left over after the short-lived Higgs decays: pairs of photons and groups of electrons, muons and neutrinos.

In coming months, the two teams will combine their data to reduce the uncertainty. They expect to have definitely con-

firmed or ruled out the Higgs by the end of 2012, when the LHC will have collected four times as much data as it has to date.

If the intriguing new bump in the data ultimately disappears, scientists will have to give up on the simplest version of the Higgs boson they've been hunting. Alternate theories propose exotic Higgs particles that are extremely heavy or decay in strange ways. Some modifications to the standard model include more than one Higgs field and two, five or even seven distinct Higgs particles, which for the most part are more difficult to find than a single particle. Other ideas do away with the particle entirely, replacing it with new forces or other kinds of particles. ■



Storm slithers around Saturn

Like a snake swallowing its tail, a giant storm wrapped itself around Saturn in December 2010 and stuck around for more than 200 days. The Cassini spacecraft orbiting Saturn captured the thundering menace in images released by the Cassini team on November 17. Scientists estimate that the storm ultimately covered more than 4 billion square kilometers. The tempest, the longest-lasting storm observed on the planet, coiled around the northern hemisphere and tore a giant hole in the deeper layers of Saturn's atmosphere. Instruments aboard Cassini recorded evidence of lightning flashing within the swirling clouds more than 10 times a second when the storm was at its most intense. Scientists liken this storm to a volcanic explosion on Earth. They are stumped by Saturn's weather patterns, which seem to produce these outbursts every two to three decades. — *Nadia Drake*

NASA, JPL-CALTECH, SPACE SCIENCE INSTITUTE

312
candidatesPossible planets
found by Kepler
as of June 2010**1,235**
candidatesPossible planets
found by Kepler as
of February 2011**2,326**
candidatesPossible planets
found by Kepler as
of December 2011

Extrasolar orb occupies just right spot for life

Planet hunters add more than 1,000 new candidates

By Nadia Drake

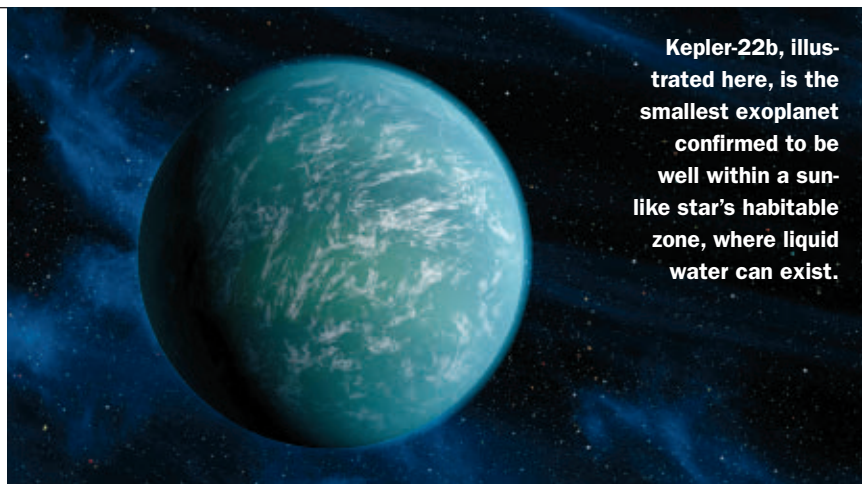
One of the many worlds circling faraway suns is tracing a most Earthlike path: The planet Kepler-22b has a 290-day orbit that parks it firmly within its star's life-friendly zone, scientists announced December 5.

With a radius 2.4 times Earth's, Kepler-22b is the smallest planet confirmed to sit comfortably in a sunlike star's "habitable zone," where temperatures allow liquid water to exist. Kepler-22b's home star — shining 600 light-years away near the constellation Cygnus — is very similar to the sun, though a bit cooler.

"Today's discovery is a tantalizing indication that, with time, Kepler might find true Earth analogs, if they exist," said Pete Worden, the director of NASA's Ames Research Center in Mountain View. The Kepler team's goal is to detect Earth-sized exoplanets within the habitable zones of their parent stars, a task that requires years of observing time.

The space telescope stares at a patch of sky near the constellations Cygnus and Lyra that sparkles with more than 150,000 stars. A planet passing in front of one of these stars produces a telltale dimming in the star's light, and scientists use these flickers to calculate a planet's radius and orbital period. The team waits for three of these dimming events before considering whether a planet might be the culprit, which is why detecting longer, Earthlike orbits takes years.

The telescope spotted Kepler-22b's first transit just after observations began in 2009, and the third transit occurred just before Christmas 2010. "It's a great gift," said Kepler principal investigator



Kepler-22b, illustrated here, is the smallest exoplanet confirmed to be well within a sunlike star's habitable zone, where liquid water can exist.

Bill Borucki of Ames. "We consider this sort of our Christmas planet."

But Kepler-22b isn't everything planet hunters could wish for. Astronomer Sara Seager of MIT said the planet's size suggests the presence of an atmosphere with a massive greenhouse effect. "It's going to be hot," she says. "Too hot at the surface for life to survive."

Planetary scientist Abel Mendez of the University of Puerto Rico in Arecibo has used Kepler-22b's radius to calculate possible masses and densities. Mendez says the most optimistic habitable scenario would be if Kepler-22b were a sort of water planet, with a global ocean and some clouds. But even that is only marginally life-friendly, he noted. "I'm not optimistic," Mendez said. "But I would love to be wrong."

Scientists initially speculated that temperatures on Kepler-22b would hover around 72 degrees Fahrenheit. But that calculation was based on an atmosphere with Earthlike properties and warming effects. Scientists can't determine whether the planet is truly Earthlike in composition without knowing its mass. If they did know how heavy Kepler-22b is, they could determine the planet's composition — rocky, watery or gassy.

Seager's scenario assumes that Kepler-22b is a gassy planet, a mini-Neptune, the likes of which are absent from Earth's own solar system. But it's possible that Kepler-22b is just a dense,

rocky planet. If it is really dense, with a thin atmosphere, then there's a chance it could be habitable, Seager said.

So far, the telescope's 1,000-day stare has allowed it to glimpse thousands of potential planets, including 1,094 new candidates just announced. These newbies bring the total number of exotreasures in the Kepler clutch to 2,326, including 207 Earth-sized — and smaller — planets. "Not only do we have Earth-size planets, we have planets that are significantly smaller than Earth," said Kepler scientist Natalie Batalha of San Jose State University in California.

Providing tantalizing targets for those in search of intelligent life are another 10 potential Earth-sized candidates in their stars' habitable zones. Five are "very, very viable candidates," Batalha said, noting that about 20 percent of the candidate planets are organized in planetary systems, making it easier to confirm the presence of the littlest, most Earthlike orbs.

Astronomer Jill Tarter of the SETI Institute in Mountain View said she and her team will be using the Allen Telescope Array in California to eavesdrop on the entire Kepler field and listen for radio signals of intelligent origin. "We're once again looking at all the Kepler exoplanets," she said. But she added, "We will give a higher priority to those worlds that our colleagues tell us are not too warm and not too cold, but just right." ■

Life

“There’s a deeper history that’s been missing from the fossil record.” —KEVIN PETERSON

Biology’s big bang had a long fuse

Animals started evolving long before showing up as fossils

By Susan Milius

A new effort to date the early history of modern animals finds a lot of evolutionary dawdling.

The last common ancestor of all living animals probably arose nearly 800 million years ago, a multidisciplinary research team reports in the Nov. 25 *Science*. From that common ancestry, various animal lineages diverged and evolved on their own paths. Yet the major animal groups living today didn’t arise until roughly 200 million years later, in an exuberant burst of forms preserved in fossils during what’s called the Cambrian explosion.

“There’s a deeper history that’s been missing from the fossil record,” says study coauthor Kevin Peterson of Dartmouth College. He and his colleagues have been pushing back that date for a last common ancestor, and now, he reports, the analysis has the broadest reach yet. “We show that animals evolved quite a bit before they show up in the fossil record.”

This work updates the notion of a long evolutionary lag, when much of the basic biological toolkit was already in place for a later surge of new body forms, says paleontologist and study coauthor Douglas Erwin of the National Museum of Natural History in Washington, D.C., and the Santa Fe Institute.

“The Cambrian explosion is like the industrial revolution,” Erwin says. Inventions that would later be important for a major shift in technology—or, in this case, genetic novelties important for evolution—appeared long before they played a role in widespread changes that had a major impact on life.

For understanding animal origins,



The evolutionary extravaganza that began more than 500 million years ago spawned early arthropods such as the *Olenoides* trilobite (left) and the proposed spider relative *Sidneyia*.

the new paper “is really worthwhile as it stands back and tries to make sense of the whole picture,” says James Valentine of the University of California, Berkeley, who studies animal evolution.

Just what happened with animals during that Cambrian explosion remains one of the more celebrated puzzles in the history of life. Charles Darwin mused over how diverse animal forms appear suddenly (geologically speaking) without much in the way of precursors. Darwin’s answer, as Erwin puts it, was that paleontologists just needed to look harder.

More than a century of hard looking has turned up some signs, fossils as well as traces of biological chemistry, of enigmatic animal life before the Cambrian period began about 541 million years ago. Yet the relationship to modern animals often is not clear. Theories themselves have exuberantly exploded in number and form.

For the new study, Erwin and the rock side of the team updated the

scorecard on the earliest fossil occurrences with recent fossil finds and the current thinking on dates of rock layers. On the molecular side, Peterson and his colleagues expanded the family tree to cover seven genes from more than 100 different kinds of living animals. Fossils provided dates for a scattering of branch points in the tree, allowing researchers to estimate when major groups arose.

Combining fossil dates and the DNA analysis, Peterson, Erwin and their colleagues conclude that the basic genetic tools for fancy animal bodies arose long before a surge of evolutionary innovation around the Cambrian period gave rise to modern animal groups.

During that 200 million-year-plus run-up to the Cambrian explosion, animals did evolve more diverse cell chemistry to regulate basic genes, and the environment changed. But Peterson attributes much of the Cambrian rise of modern animal forms to changes in the interactions among organisms themselves. “You see an evolutionary explosion, if you will, because animals are eating other animals for the first time,” he says.

The paper’s discussion of toolkit genes and the diverse cell chemistry that arose to orchestrate them overlooks some possibly important complexity, objects molecular biologist Mark Q. Martindale of the University of Hawaii. At least 30 percent of the genes of animals analyzed so far have no recognizable similar gene in another species. “These so-called orphan genes could have a tremendous amount to do with diversification of animal lineages, but people just pooh-pooh these differences and focus on the things that are shared,” he says.

Some of the relationships in the evolutionary tree “have been and will continue to be controversial,” says evolutionary biologist Casey Dunn of Brown University in Providence, R.I., who wasn’t involved in the research. “But the point of the tree isn’t the relationships themselves—it is some key dates.”



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Eggs have own biological clock

Aging mechanisms in worm reproductive cells are distinct

By Tina Hesman Saey

Egg cells age differently than cells in the rest of the body, a new study shows.

The finding, from experiments with roundworms presented December 5, might one day lead to ways to predict how long women will stay fertile or even to extend a woman's fertile years.

Princeton University biologist Coleen Murphy and her colleagues study aging in the roundworm, *Caenorhabditis elegans*. The worms typically live for about 21 days, but their fertility drops off sharply after the first week and the worms can no longer reproduce after they are about 9 days old. Even though 9-day-old worms still have plenty of eggs left, the egg cells, or oocytes, are of such poor quality they can't produce embryos.

Women experience a similar sharp decline in fertility starting in their late 30s. This drop-off in reproductive capability is one of the earliest signs of aging.

In earlier work, Murphy and her colleagues tested whether mutations that

extend life span in worms also lengthen the animals' fertile period. Those experiments found that certain mutations in biological processes regulated by insulin prolong worms' lives and give them about three extra fertile days. Mutations in a different biological process, controlled by a protein called TGF-beta, extend fertility but not life span. But the older TGF-beta mutant mothers' muscles get too weak to lay eggs, and the animals essentially die in childbirth, Murphy said.

In the new study, the researchers examined which genes are turned on or off to prolong life and fertility in the oocytes and other body cells of the long-lived worms.

"We were really surprised to find this was a completely different mechanism" controlling aging in eggs compared with other body cells, Murphy said. "In fact, there was almost no overlap between

the genes involved in the long life of worms and those that extend fertility in the oocytes."

Body, or somatic, cells are known to turn on stress-management genes to protect proteins and change metabolism as they age. But oocytes don't bother with guarding proteins, Murphy and her colleagues found. Instead, eggs ramp up production of factors that protect them from or repair DNA

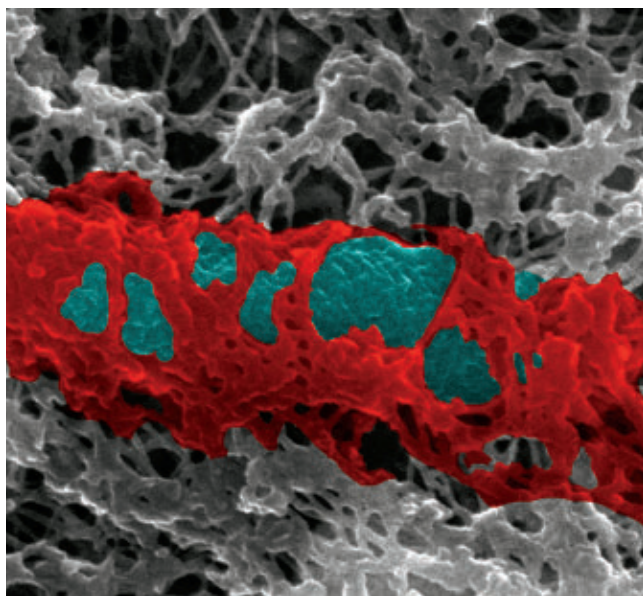
damage and make more of proteins that help egg cells divvy up their chromosomes correctly, the researchers reported.

Because the entire job of an egg is to provide genetic information used to build a new generation, it is perhaps not so surprising that eggs devote resources to making

sure the DNA stays healthy and chromosomes are allocated properly, said Craig Blackstone, a physician and researcher at the National Institute of Neurological Disorders and Stroke in Bethesda, Md. "It makes sense that this would happen, but it hadn't been shown before," he said. "It's clever of her to study this." ■

"We were really surprised to find this was a completely different mechanism."

COLEEN MURPHY



Bacteria in bondage

Cells can trap some invading bacteria and slate them for destruction, a new study shows. Serge Mostowy and Pascale Cossart of the Pasteur Institute in Paris discovered that when a type of diarrhea-causing bacteria called *Shigella* (blue) gets inside cells, the cells fight back by encasing 10 to 30 percent of the bacteria in cages made of proteins called septins (red). The cells then digest the trapped bacteria in a cellular process called autophagy, Cossart said December 4. The entrapment strategy works only on bacteria that are actively grabbing a cellular protein called actin and adding it to the cometlike tails that the microbes use to propel themselves through the cell. And the septins and autophagy proteins have to work together: If either fails to latch on to a bacterium, the microbe can escape. The findings could eventually help researchers develop new therapies against *Shigella* and some other disease-causing bacteria by boosting cage-building components.

—Tina Hesman Saey

S. MOSTOWY

Pituitary gland grown in a dish

Hormone-producing organ produced from stem cells

By Tina Hesman Saey

Scientists have grown a mouse pituitary gland for the first time from embryonic stem cells. Or rather, the gland grew itself after researchers coaxed embryonic stem cells to form the type of tissues that normally surround the gland.

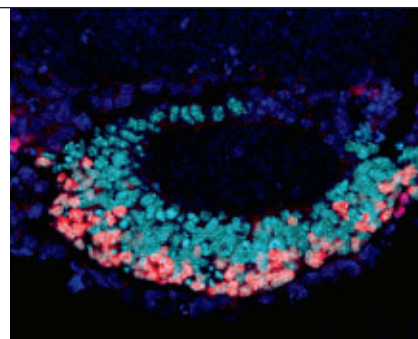
The feat, reported online November 9 in *Nature*, could be the first step toward replacement pituitaries for people. Glands grown in lab dishes may also help researchers learn how the organs develop in the body.

“There’s a lot in it to be excited about, whether you’re a developmental

biologist or interested in clinical applications,” says Sally Camper, a developmental geneticist at the University of Michigan in Ann Arbor. Camper has tried, and failed, to coax embryonic stem cells to form pituitary glands.


Yoshiki Sasai of the RIKEN Center for Developmental Biology in Kobe, Japan, and colleagues succeeded by re-creating conditions that exist in the brain where the pituitary normally grows. The researchers used chemicals to coax mouse embryonic stem cells to form two types of brain tissue in a lab dish. Where those two tissues meet in the brain is where the pituitary forms, so the researchers manipulated conditions such that the tissues would form side-by-side. The researchers then applied a protein that directs tissue development.

A fold of tissue called Rathke’s pouch formed between the two tissues and eventually grew into a pituitary gland,



Precursors of hormone-producing pituitary endocrine cells (red) form among more primitive cells (blue-green).

complete with the five different types of hormone-producing cells found in a naturally formed gland. The dish-grown gland secretes one of those hormones, adrenocorticotrophic hormone, both in a lab dish and when transplanted in mice.

Sasai says his group is testing to see if lab-grown glands can make other pituitary hormones. 

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He's not a rat, he's my brother

Rodents exhibit empathy by setting trapped friends free

By Laura Sanders

Calling someone a rat should no longer be considered an insult. The often maligned rodents go out of their way to liberate a trapped friend, proactive behavior that's driven by empathy, researchers conclude in the Dec. 9 *Science*.

"As humans, we tend sometimes to have this feeling that there's something special about our morals," says neuroscientist Christian Keysers at the Netherlands Institute for Neuroscience in Amsterdam, who was not involved in the study. "It seems that even rats have this urge to help."

As many pet rat owners know, rats are highly social animals, says study coauthor Inbal Ben-Ami Bartal, a psychologist at

the University of Chicago. Bartal and colleagues wanted to see whether rats would take action to ease the suffering of a cage mate. The team put one rat inside a clear cage that could be sprung from the outside and left another rat to roam free outside the cage for an hour at a time.

Initially, the free rat would circle the cage, digging and biting at it. After about seven days of encountering its trapped friend, the roaming rat learned how to open the cage and liberate the captive. "It's very obvious that it is intentional," Bartal says. "They walk right up to the door and open the door." The liberation is followed by a frenzy of excited running.

The rats would selectively take action when another rat was in distress: Empty cages didn't inspire rats to learn how to open the door nearly as well as those who were motivated to rescue a trapped rat. By the end of the experiment, only five of 40 rats learned to open an empty cage, while 23 of 30 rats learned to open the cage to free an occupant. (Trapped stuffed animals fared no better than empty cages.)

"If I open the door, that rat's distress goes away and my distress goes away," says psychologist Matthew Campbell of Yerkes National Primate Research Center at Emory University in Atlanta, who studies empathy in chimpanzees. "They are affected by what the other is experiencing, and that alone is remarkable."

To push the limits of the rats' goodwill, Bartal's team pitted a trapped rat against trapped chocolate, forcing a rat to choose which to release first. "These rats adore their chocolate," she says. The rats were equally likely to free a rat in distress as they were to free the sweets. To a rat, a friend's freedom was just as sweet as five chocolate chips.

"The most shocking thing is they left some of the chocolate for the other rat," Bartal says. The hero rat left a chocolate chip or two for its newly free associate in more than half of the trials. On purpose.

"It's not like they missed a chocolate," Bartal says. "They actually carried it out of the restrainer sometimes but did not eat it." ■

Coffee delivers jolt deep in brain

Caffeine strengthens electrical signals in rats' hippocampus

By Laura Sanders

Most coffee addicts would tell you that caffeine sharpens the mind. It turns out that in rodents, a single dose of caffeine does indeed strengthen cell connections in an underappreciated part of the brain, scientists report online November 20 in *Nature Neuroscience*.

A clearer idea of caffeine's effect on the brain could allow scientists to take advantage of its stimulating effects and perhaps even alleviate some brain disorders.

So far, most of caffeine's effects have been studied at doses much higher than in an average cup, says study coauthor Serena Dudek of the National

Institute of Environmental Health Sciences in Research Triangle Park, N.C.

Her team tested smaller hits of caffeine on a part of the hippocampus. In humans, this seahorse-shaped structure is buried deep in the brain behind the ears. After feeding rats a caffeine dose equivalent to two human cups of coffee (two milligrams of caffeine per kilogram of body weight), the team measured

the strength of nerve cells' electrical messages in slices of brain tissue. Nerve cells in this particular nook—a region called CA2—showed a bigger burst of electrical activity when researchers stimulated the cells. Nerve

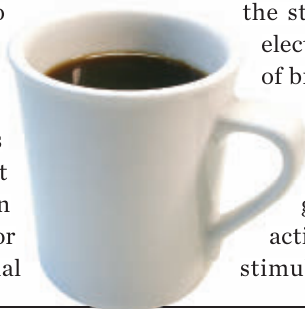
cells in a nearby part of the hippocampus didn't show this sensitivity.

And the higher the caffeine dose, the stronger the effect. A caffeine dose 10 times higher—a dose reached by only die-hard caffeine consumers—caused an even bigger response in CA2 nerve cells.

Similar effects occurred when applying caffeine directly to CA2 nerve cells in a dish, ruling out post-caffeine changes in blood flow as the cause. After five minutes of caffeine exposure, the cells stayed amped up for three hours.

These strengthened cell connections may have a role in learning and memory, as a main job of the hippocampus is to form spatial memories. But it's unclear how the research will apply to people.

"It's hard to jump from these kinds of studies to direct application to humans," says psychologist Harris Lieberman of the U.S. Army Research Institute of Environmental Medicine in Natick, Mass. 



“We’ve created the perfect habitat for this ectoparasite that lives in mammals’ nests.” —RAJEEV VAIDYANATHAN

Inbreeding helps bedbugs’ success

Pests have also grown resistant to common insecticides

By Nathan Seppa

Bedbugs that infest a room and spread within a building are often one big extended family, the offspring of a single female that begot sons and daughters that then interbred with impunity, researchers reported December 6.

Other scientists reported on mechanisms that allow bedbugs to escape death by rapidly evolving to detoxify insecticides thrown their way. In that study, the researchers identified enzymes that the insects need in this detoxification process.

Cimex lectularius, the bedbug, has become a scourge of slum tenements and upscale hotels alike in the past 10 years, staging an impressive comeback after being knocked back to insignificance with insecticides in the 1950s and 1960s. But even before that there were hints of future problems, said entomologist Kenneth Haynes of the University of Kentucky. The first reports of the insecticide DDT failing to kill bedbugs surfaced in 1948, he noted.

To get a reading on the current level of resistance, Haynes and his colleagues tested 108 bedbug populations and found that 88 percent had one or two genetic mutations associated with resistance to either DDT or pyrethroids, a widely used family of pesticides. “Pyrethroid resistance has facilitated in part the resurgence and/or spread of bedbugs,” Haynes said. The group traced this resistance to genetic changes that enabled the bugs to produce enzymes that detoxify insecticides. To establish this conclusion, the researchers shut down the enzymes’ production, which rendered the bugs vulnerable to deltamethrin, a synthetic pyrethroid.



Bedbugs have enjoyed a resurgence in recent years, thanks in part to resistance to pesticides.

But bedbugs do more than survive; they reproduce like crazy. Entomologist Coby Schal of North Carolina State University and his team investigated apartment buildings that had reported infestations and found bugs’ genetic material typically showed stunning similarities, suggesting a single mother. “This is an extremely high level of inbreeding,” Schal said, and it apparently didn’t harm the insects’ survival.

By studying dozens of infestations from Maine to Florida, the researchers found that diversity does exist in the bedbug world—among infestations that are cities apart. The difference is great enough to indicate that the current bedbug crisis couldn’t have arisen from a single introduction of bedbugs that then spread like wildfire. Rather, the bugs’ clear diversity between cities suggests many arrivals from outside the United States, Schal said, pointing to a downside of global interconnectedness.

While insecticide resistance and global travel appear to have conspired to bring on the bedbugs, humans are assisting in other ways, says Rajeev Vaidyanathan of SRI International in Harrisonburg, Va. “The resurgence of these bugs didn’t happen overnight,” says Vaidyanathan. “For the first time in the history of our species, we are concentrated in cities. We’ve created the perfect habitat for this ectoparasite that lives in mammals’ nests.”

MEETING NOTES

Averting chikungunya virus

A vaccine against the chikungunya virus has proven protective in tests in monkeys, researchers reported. First identified in the 1950s in East Africa, the mosquito-borne virus cropped up in the Democratic Republic of the Congo in 1999 and in Kenya in 2004 and has since caused major outbreaks in India and Southeast Asia. In people, chikungunya infection can cause fever, joint pain and other symptoms, some severe. In the new study, scientists at Tulane University and the University of Texas Medical Branch at Galveston gave a one-dose vaccine to 12 macaque monkeys, then exposed the animals to the virus. None developed disease. Unvaccinated monkeys that were exposed developed hypothermia and heart and lung distress. —Nathan Seppa

Dengue vaccine tests advance

A vaccine against dengue provides immunity against all four strains of the virus in most recipients and is safe to take, researchers in Singapore reported. The preliminary results come from a trial involving 1,200 volunteers ages 2 to 45 randomly assigned to get either all three doses of the dengue vaccine spaced over a year or a control vaccination. The scientists detected signs of immunity against three of the four dengue subtypes in 87 percent of vaccine recipients tested and against all four subtypes in 67 percent. Dengue can cause pain, headache and hemorrhagic fever. Other scientists at the meeting reported that 13 clinical trials are now under way testing various dengue vaccines. —Nathan Seppa



Metal crust, superconductor filling

Material could harbor particle that's its own antimatter twin

By Devin Powell

A new kind of superconductor can't make up its mind about how to conduct electricity. Current passes through its interior without any resistance, as in a typical superconductor. But its skin behaves like a metal, conducting electricity but with some resistance.

This split personality, described in the Nov. 18 *Physical Review Letters*, could be the handiwork of something strange hiding on the surface—a two-dimensional entity behaving like a Majorana fermion. First proposed more than 70 years ago, a Majorana fermion is a theoretical type of particle that is its own antiparticle. Electrons and quarks and other particles of matter all have oppositely charged antimatter partners.

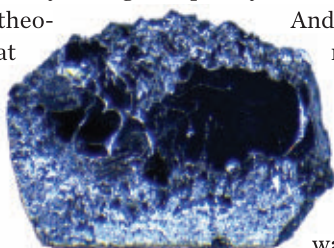
Some theorists who suspect that neutrinos are their own antiparticles would be excited to find evidence that anything can act like a Majorana fermion, even the surface of the superconductor in the new study. Others hope that such particles could be useful for storing information in new kinds of computers.

"This is great," says Robert Cava, a chemist at Princeton University who wasn't involved with the study. "Hopefully it will get people excited about this material."

Cava and colleagues were the first to create the material, made of copper, bismuth and selenium layered like lasagna. They showed that it's a superconductor at temperatures within a few degrees of absolute zero. But until now, no one

had conclusively proven that this superconductivity is any different from the run-of-the-mill variety discovered in mercury a century ago.


To probe the material, Yoichi Ando of Osaka University and colleagues in Japan injected current into it using a gold wire. This excited electrons at the surface, creating ripples of energy. Conventional superconductors have a dead spot in their surfaces that prevents low-energy, slow-wobbling ripples from forming. But a close look at this material revealed a sea of waves moving both quickly and slowly.



Ando says that this pattern of ripples is "unambiguous evidence" of a type of superconductivity never seen before: topological superconductivity, in which electrons become waves molded into a complex

shape that resembles the outside of a doughnut. These waves, says Ando, seem to be behaving like exotic two-dimensional particles at the surface of the material—specifically, Majorana fermions.

"This is the best evidence so far for Majorana fermions in a solid material," says Taylor Hughes, a theoretical physicist at the University of Illinois at Urbana-Champaign. Still, the new experiment didn't actually reveal the flat fermions themselves—only their supposed influence. No one has yet figured out how to directly detect them in solids. So it's probably going to take many sources of indirect evidence to make the case that Majorana fermions actually exist in this material, says Hughes.

One way to test the idea would be to use magnetic fields to create swirling vortices on the material's surface. These vortices should be able to trap a Majorana fermion. 

This material may contain exotic particles that could explain why the stuff behaves like a metal at the surface and like a superconductor on the inside.

NEWS BRIEFS

Diamonds are forever (entangled)

Tiffany's take note: Physicists have succeeded in joining two tiny diamonds together in the bizarre quantum state known as entanglement. Usually demonstrated in ultracold, microscopic systems involving atoms or particles of light, entanglement links two objects in a sort of quantum embrace such that measuring the state of one instantly reveals the state of the other, even if they are separated. Researchers in England, Canada and Singapore have now linked the vibrational states of two millimeter-sized diamonds at room temperature in the lab. The work, reported in the Dec. 2 *Science*, could point the way to using macroscopic objects in quantum information processing.

—Alexandra Witze

How water chills out

A new study reveals why -48° Celsius is the lowest temperature at which pure water can remain a liquid. Ice formation in such supercooled water happens too quickly to watch in the lab. But using a computer simulation, scientists at the University of Utah in Salt Lake City show that water molecules suddenly come together in groups of four at about -41° . This change to an unstable icelike liquid drives the creation of ice crystals, a process that happens quickly at first and then slows down as the temperature drops. The slowdown suggests that ice in clouds forms more slowly than previously thought, the researchers report in the Nov. 24 *Nature*.

—Devin Powell

Italian Doctor Discovers Ancient “Love Drug”

*Now available without a prescription!
Call now and get 250 carats of rich,
gorgeous garnet—for UNDER \$30!*

Today if you want to learn about gemstones, you ask a jeweler or geologist. But back in the 16th century, Italians went to see the doctor. Respected men of science and medicine believed that precious stones did more than just look pretty. They believed the power of gems could cure almost anything. And if you needed serious help in the romance department, nothing worked better than garnet. Today you can get a massive dose of the legendary gem for an unbelievable price. Call now and this stunning **250-Carat Garnet Garland Necklace**, valued at \$179, is yours for **ONLY \$29.95!**

The color of passion. In 1502, Camillus Leonardus, M.D. published his *Speculum Lapidum* (*Mirror of Stones*) about the mystical and spiritual properties of gemstones. One of the superstars of that volume was the deep-red garnet. Garnet was adored by the Greeks and Romans. In the Middle Ages, Bohemian craftsmen used it to create romantic treasures. Few stones provoke more passion, fire and desire than glowing red garnets. Today the heat still smolders.

Your love isn't average. It deserves a remarkable necklace at a ridiculous discount. We originally offered this 26" rope of enhanced garnet beads for \$179. But the Italian doctor inspired us to give garnets the big deal they deserved. After all, if a stone has been said to “dissipate sadness, avert evil thoughts and exhilarate the soul,” it begs for something special. If scholars once thought that garnets could “bring sleep to the sleepless, drive away the plague, and attract riches, glory, honor and great wisdom,” why stop at ordinary?

That's why, for the next four weeks only, you can wear this 250-Carat **Garnet Garland Necklace** for the unbelievable price of **\$29.95!** That's right, you get 250 carats for under \$30! The gorgeous necklace is an endless strand of polished garnets that perfectly complements any outfit from couture to casual. Deep color. Sparkling. Seductive. Can the legendary love powers of garnet rev up your romance? We can't say for sure, but taking your medicine has never felt like more of an indulgence!

Your satisfaction is guaranteed. The crimson sparkle of the **Garnet Garland Necklace** is something you really need to see for yourself. If you're not completely delighted, simply return it within 30 days for a complete refund of your purchase price.

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- 250 ctw of genuine semi-precious garnet - Gold-layered clasp bracelet and French hook earrings

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**Price
Guaranteed
For 4 Weeks only!**

B.

C.

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SCIENCE NEWS OF THE YEAR

You can't make this stuff up.

An earthquake and tsunami trigger the worst nuclear accident in decades, contaminating thousands of square kilometers in one of the world's most densely populated countries. Analyses of a sliver of finger bone reveal that the genes of an extinct human relative survive in many people living today. Single-celled organisms floating in a test tube join up, with a little coaxing, to create multicellular organisms in what could be a reenactment of one of the most seminal events in the history of life.

You don't have to make it up, though, because it all happened in 2011. Some of the year's revelations were downright unnerving: Sea level is rising at an accelerating rate and Arctic ice cover continues its long-term decline. On the economics front, network analysis has revealed that the world's capital really is concentrated in the hands of just a few players.

But there are reasons for optimism, too. Research hints that antidepressants can stave off Alzheimer's disease, and a vaccine against malaria shows signs of effectiveness in African children. By mining electronic medical records, researchers in Denmark have drawn possibly informative links between unlikely pairs of ailments, such as migraines and hair loss.

Then there were the stories that were just too wild to be true: Neutrinos appeared to violate Einstein's theory of relativity by flying faster than light, but other work suggests they were doing no such thing. And a 2009 study linking chronic fatigue syndrome to a wily virus called XMRV has been retracted, triggering spasms of finger-pointing among virologists.

And all of this news appeared in the pages of *Science News*. In case you missed any of it, read on.
—Matt Crenson, News Editor

On the Web For the complete year-end recap with links to the original online articles, visit www.sciencenews.org/2011

Science & Society



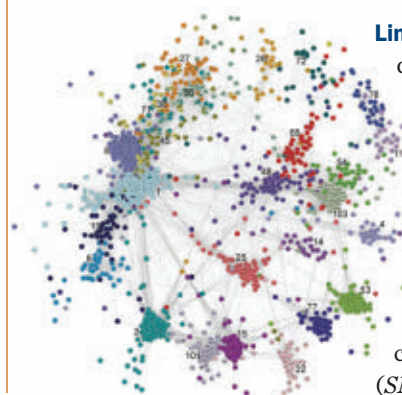
Weather unrest One in five major civil conflicts since 1950 may be linked to climate extremes associated with El Niños, a study finds (*SN: 10/8/11, p. 16*).

Rule by a few A handful of individuals can enslave an entire network, even if they aren't highly connected themselves. Scientists have found a way to identify these individuals, which might lead to more secure power grids, marketing campaigns that spread like the plague and

tricks for controlling a cell's metabolic growth processes (*SN: 6/4/11, p. 5*). Other work uses 2007 data to diagram the relationships among more than 43,000 corporations, showing that a tightly connected core controls more than one-third of global wealth (*SN: 9/24/11, p. 13*).

Acid test fails Contrary to claims made by informants within the Sicilian Mafia, sulfuric acid won't dissolve a corpse in minutes, research reveals (*SN: 3/26/11, p. 16*).

Linked up Integrating data from clinicians' notes with protein and genetic information reveals connections (network shown) between health problems as seemingly unrelated as migraines and hair loss, or glaucoma and a hunching back (*SN: 10/8/11, p. 16*).





Following earthquake and tsunami, radiation is Japan's true aftershock

The worst earthquake in Japan's recorded history—and, at magnitude 9.0, one of the most powerful ever recorded—didn't end when the shaking did on March 11. Within hours, a meters-high tsunami swamped much of the coastline, including the Fukushima Daiichi nuclear power station, setting off the worst nuclear accident since the 1986 Chernobyl meltdown in Ukraine (*SN*: 4/9/11, p. 5).

Three reactors at the Fukushima plant exploded, releasing radioactivity carried by winds across Japan and then around the globe (*SN Online*: 3/19/11). Radiation physicists continue to argue about how much radioactive material, such as cesium-137, escaped, with independent assessments often coming in much higher than the Japanese government's official numbers. In late November the Tokyo Electric Power Co., which operates the plant, announced that at the worst-hit reactor, Unit 1, fuel rods had probably melted completely during the accident and pooled in the concrete bottom of the containment vessel.

Workers continue to try to cool and stabilize the damaged reactors; it could be years before the cores can be opened up and disposed of. Meanwhile, villages around the plant remain evacuated and may be uninhabitable for decades. —Alexandra Witze

Workers in protective suits and masks wait to enter the crippled Fukushima Daiichi nuclear power station, where efforts to stabilize damaged reactors are still under way.

Crop dents Farms around the planet produced 3.8 percent less corn and 5.5 percent less wheat than they could have between 1980 and 2008 because of rising temperatures, a new analysis estimates (*SN*: 6/4/11, p. 15).

Personnel stress Service and support personnel face considerable and often overlooked war stress (*SN*: 9/24/11, p. 9).

The data age The fraction of the world's data stored digitally has skyrocketed from

about 0.8 percent in 1986 to 94 percent in 2007, a study finds. By 2007, the same analysis reveals, video game consoles were doing 25 percent of the world's computing, and cell phones were doing 6 percent (*SN Online*: 2/10/11).

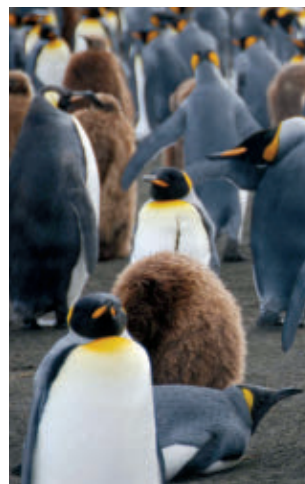
Vanishing act Methane, the predominant hydrocarbon produced by the BP blow-out in 2010, has all but vanished from Gulf of Mexico waters—presumably eaten up by marine bacteria. That hadn't been expected for years (*SN*: 1/29/11, p. 11).

NIH gap Among minority scientists applying for U.S. National Institutes of Health research grants, blacks alone face a substantially lower likelihood of being successful than whites, a study finds (*SN Online*: 8/18/11).

Dirty deeds A network analysis of Enron e-mails reveals that electronic missives regarding dirty dealings tend to transpire through a sparse hub and spoke network, rather than a highly connected web (*SN*: 7/2/11, p. 9).

War air U.S. soldiers in Iraq must contend with air that's laden with heavy metals and lung-ravaging particles (dust storm in Baghdad shown at left) (*SN*: 4/23/11, p. 15).

Double threat Amoebas appear to contaminate drinking-water systems around the world (*SN*: 2/26/11, p. 9).



Penguin harm Scientists may be causing long-term harm to penguins by tagging their flippers with metal ID bands (*SN*: 2/12/11, p. 10).

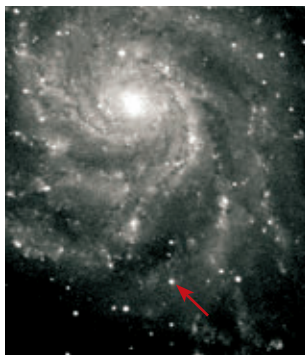
Bandwagon rewards Day traders who act in sync—no matter the stock, or whether they are buying or selling—make more money at the end of the day than their out-of-sync peers (*SN Online*: 3/14/11).



Still shining Some of the universe's first stars may still be shining in the Milky Way, 13.4 billion years after forming, disputing the prevailing view that early stars died out quickly (*SN: 2/26/11, p. 18*).

Boom, then zoom

Telescopes capture a white dwarf star going supernova (below, arrow) just 21 million



light-years away (*SN: 9/24/11, p. 5*).

Rocks of life Life-related chemicals are found in nearly a dozen meteorites, the strongest evidence yet that space rocks contain the building blocks of DNA and could have delivered them to Earth (*SN Online: 8/10/11*).

Superhot solution NASA's Solar Dynamics Observatory spots fountainlike jets of hot gas that shoot into the sun's outer atmosphere, possibly explaining why it is millions of degrees hotter than the solar surface (*SN: 1/29/11, p. 12*).

Good-bye shuttle Three decades after the first

launch, the space shuttle program ends its run (*SN: 6/18/11, p. 20*). NASA also announces its pick of designs for a heavy-lift rocket to take next-gen astronauts into space.

Solar doldrums Scientists predict that the sunspot cycle that began in early 2008 will be the weakest in 200 years (*SN: 3/26/11, p. 5*). Studies also suggest that a period of reduced solar activity could help cool the climate (*SN: 7/16/11, p. 12*).

Exoplanet bonanza

A bevy of exoplanets are added to the growing list, including the first confirmed rocky planet beyond the solar system (*SN: 2/12/11, p. 12*) and a planet with a radius 2.4 times larger than Earth's parked firmly within its star's life-friendly zone (*SN: 12/31/11, p. 11*).

Last words The Fermi National Accelerator Laboratory's Tevatron (below) shuts down after a quarter century (*SN: 9/24/11, p. 22*). Before the closing, scientists discover the Xi-sub-b particle, predicted by the standard model of particle physics (*SN: 8/27/11, p. 14*).

Lurking lakes Europa's chaotic surface features signal the presence of large pockets of liquid water tucked into the Jupiter moon's rock-hard ice, scientists report (*SN: 12/17/11, p. 5*).

Fluid situation Analyses of mineral data hint that Mars' ancient surface may have been cold and frigid, with fluids appearing only beneath the planet's ruddy sands (*SN: 12/3/11, p. 5*).

Mercury close-up NASA's MESSENGER spacecraft returns the first images ever taken by a probe orbiting Mercury, showing parts of the south and north polar terrains (*SN Online: 3/30/11*).

Dark check Astronomers looking at distortions of microwaves left over from the Big Bang independently confirm the existence of dark energy (*SN: 8/13/11, p. 18*).

Crabby flares The Crab Nebula hurls gamma-ray flares more energetic and five times brighter than any previously recorded, challenging theories about how the heavens accelerate charged particles (*SN: 6/4/11, p. 10*).

Not so fast, neutrinos

News of particles zipping along faster than light (*SN: 10/22/11, p. 18*) was met with universal skepticism—including from the physicists in Italy who reported the results. But the Gran Sasso National Laboratory's OPERA team hasn't found any source of error that could explain how the neutrinos appeared to shave 60 nanoseconds off of light-speed travel time while covering the 730 kilometers from the CERN physics laboratory near Geneva to Gran Sasso.

Einstein's special theory of relativity says such speeds shouldn't be attainable. And even if they were, the neutrinos would have shed observable energy during flight, report physicists at Boston University (*SN: 11/5/11, p. 10*). Critics suggest that at the different locales gravity may have pulled on the clocks with different strengths, causing the timekeepers to tick at different rates. Or some of the particles in the neutrino bunches could have started the trip earlier than thought.

Faced with these criticisms, the OPERA team has used shorter, sharper pulses of particles to check the results. The researchers say the findings still stand, but other large neutrino projects plan to repeat the experiment. —Devin Powell





Crash course The Genesis probe (above, after crashing in Utah) finds that, compared with the sun, the Earth is enriched in two types of oxygen and one of nitrogen (SN: 7/16/11, p. 5).

Superdupernova A new class of supernovas emit much of their light at ultraviolet wavelengths and show no traces of hydrogen (SN: 7/2/11, p. 10).

Probe payoff Gravity Probe B confirms that the Earth drags spacetime as it rotates, an effect known as “frame dragging” that is predicted by Einstein’s general theory of relativity (SN: 5/21/11, p. 5).

Hints of the Higgs

Two experiments at the Large Hadron Collider find hints of the elusive Higgs boson, the last missing piece in particle physics’ standard model (SN: 12/31/11, p. 10).

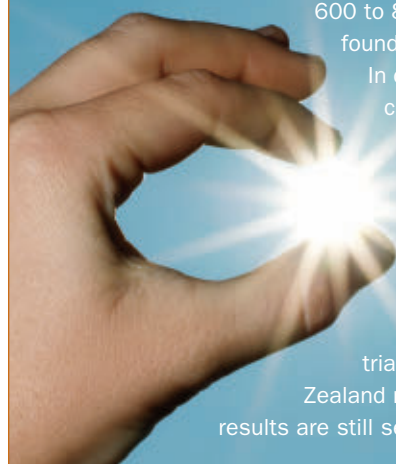


The value of vitamin D

The simmering debate over vitamin D came to a boil as the scientific organization representing hormone experts embraced daily recommendations for the vitamin that far exceed those put forward in late 2010 by a U.S. Institute of Medicine panel. The Endocrine Society asserted in July that people need two to three times as much vitamin D as the IOM had recommended (SN: 7/16/11, p. 22). The IOM daily levels top out at 600 to 800 international units for most people, the amount found in many multivitamins.

In calling for substantially more D, the endocrinologists cited widespread deficiency in all age groups and pointed out that very few foods naturally contain the vitamin.

A torrent of recent studies have linked vitamin D deficiency—particularly at northern latitudes—with heart disease, cancer, infections, asthma, preterm births, high blood pressure and, among the elderly, difficulty with mental tasks. Two trials now in progress in the United States and New Zealand may clarify the vitamin’s health-giving potential. But results are still several years off. —Nathan Seppa



Scant B12 Studies in the elderly link impairments of memory and reasoning with vitamin B12 deficiency. And brain scans show that people lacking B12 are more likely to have shrinkage of brain tissue and vascular damage (SN Online: 9/27/11).

Dietary details An analysis assigning pounds of weight gain to foods finds that fries, sodas and several other guilty pleasures are among the worst waist expanders (SN: 7/30/11, p. 10).

Yogurt letdown Eating yogurt doesn’t lead to long-lasting changes in a person’s mix of intestinal microbes (SN: 11/19/11, p. 18).

On the mind Obesity subtly diminishes memory and other features of thinking and reasoning even

among seemingly healthy people, possibly by damaging the wiring that links the brain’s info-processing regions (SN: 4/23/11, p. 8).

Brainy sabotage Obese people’s brains respond to food as if the body were hungry even when it isn’t, suggesting dieters may be on the losing side of a battle with neural centers that promote eating (SN: 10/22/11, p. 16).

Chocolate diet Compounds in chocolate can ratchet down digestive enzymes that the body relies on to absorb and use fats and carbohydrates (SN Online: 5/9/11).

Saffron surprise Tests show that saffron (flower at right) can stifle liver cancer in rats (SN: 10/8/11, p. 14).

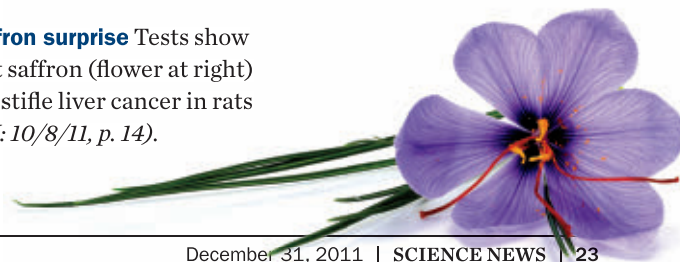
Blueberry boon

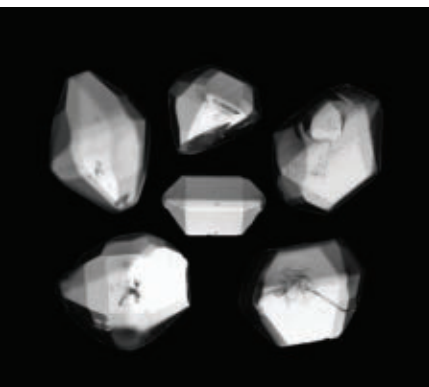
Heart-healthy compounds found in blueberries limit the buildup of fat in mouse cells (SN Online: 4/20/11).

Dioxin flare-up Frying at high temperatures can trigger the development of potentially toxic dioxins and furans in food (SN Online: 5/9/11).

Cough for quality

Sensor molecules found in the human throat latch onto a chemical in superior olive oils, providing a scientific basis for the age-old custom of rating superlative oils on a scale of one, two or three coughs (SN Online: 1/18/11).





Timely boom By reining in a supersensitive explosive with good old-fashioned TNT, chemists have created a new crystal (above) that can be stored and transported safely and then quickly converted to an active, superexplosive form (*SN: 10/22/11, p. 10*).

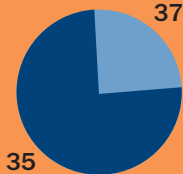
Absent interface About a quarter of the molecules in water's superthin surface layer can't decide whether to be liquid or gas, but the ambiguity doesn't affect the water below (*SN: 7/2/11, p. 13*).

Table gets flex The atomic weights of 10 chemical elements in the periodic table (including chlorine, below) are listed as ranges rather than single numbers, the first phase in an overhaul of almost every element in the table (*SN: 1/29/11, p. 5*).

chlorine

Cl

17



[35.446; 35.457]

Microbial work-around

Researchers discover the “methyloaspartate cycle,” a means for synthesizing cellular building blocks cobbled together by salt-loving microbes (*SN: 2/12/11, p. 14*).

High blocker Modifying the active ingredient in marijuana, THC, may allow researchers to quash the high that THC produces. The doozy sensation is an unwanted side effect for some people who use marijuana for its medical effects (*SN Online: 4/24/11*).

Green flame fighters

Flexible coatings mere billionths of a meter thick keep cotton clothing from going up in flames and plastic foam from melting — and they're safer than the toxic flame retardants currently in use (*SN: 9/24/11, p. 17*).

Bottom up With the help of template molecules, scientists manage to string small biologically important molecules together into larger, ringed structures (*SN: 1/29/11, p. 16*).

DEET's deets The repellent works its magic from afar by gumming up insects' sniffing machinery (*SN: 10/22/11, p. 10*).

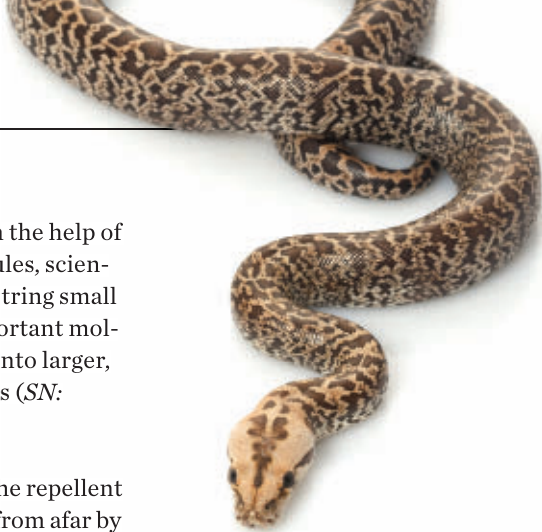
Lab relief Chemists have synthesized a pain-relieving extract, called conolidine, from the bark of a tropical shrub, paving the way for new drugs that lack the unwanted side effects of many opiate-based meds (*SN Online: 5/23/11*).

One poison A type of caterpillar makes cyanide via the same cellular machinery as its host plant, the first known example of organisms from

different kingdoms evolving the same biochemical treachery (*SN: 5/7/11, p. 11*).

Python elixir A mix of fatty acid compounds identified in pythons (above) can spur an exercise-like boost in the size of mouse hearts (*SN: 12/3/11, p. 12*).

Plastic isn't over A new polymer can be heated and reconfigured into complex shapes without losing its strength, meaning broken bits can be repurposed (*SN: 12/17/11, p. 8*).



Molecular muscle does the job

Chemists often wish they could reach into a test tube and physically force a chemical reaction—and now they've come pretty darn close. In a feat of molecular arm-twisting, researchers attached polymer chains to an extremely stable ring-shaped molecule and tore it in two (*SN Online: 9/15/11*). The new approach split the triazole ring, a compound found in many drugs and fungus-fighting chemicals, into its molecular building blocks, reversing the reaction that brought the ring together.

“It's a way to almost literally put your hands on molecules and twist them or turn them in whatever way you want,” says Christopher Bielawski of the University of Texas at Austin, who led the research. Chemists often use heat to break compounds apart, but the approach can yield a variety of molecular pieces. And heat and other chemical tricks don't work on the triazole ring, because it is too tough.

Bielawski and his students attached chains to opposite sides of the rings in solution and then inserted an ultrasound probe. The probe generated imploding bubbles, creating tiny pockets of suction that yanked on the polymer chains and tore open the rings. The technique reverses a reaction that was thought to go in only one direction, suggesting a new means for strong-arming other molecules into interesting new chemistry.

“This work is going to have a big impact,” says Virgil Percec of the University of Pennsylvania. “It opens the door to unexpected new opportunities.” —Rachel Ehrenberg

0.5 meters | Average yearly retreat of Arctic coastlines

Arctic warming signs

Climatologists pointing to the Arctic as the leading barometer of global change have plenty of new evidence that wholesale warming is under way. Observational data indicate that the region's air, soils and water have warmed substantially since 2006, suggesting that the climate has established a "new normal" (*SN Online*: 12/2/11). Among the symptoms: An anomalous pool of freshwater (27 meters deep in places) fed by inland meltwater has been found floating atop Arctic Ocean seawater (*SN Online*: 4/5/11). Erosion is also up across the Arctic, with area coastlines retreating on average by a half-meter per year (*SN*: 5/21/11, p. 13).

This year's summer sea ice extent, a common marker for how bad things are getting, either approached or matched 2007's record low, depending on which data scientists use (*SN Online*: 9/14/11; *SN Online*: 10/6/11). And computer projections by 19 different global climate programs indicate



Researchers are measuring rapid erosion along the Arctic coast (Alaskan permafrost shown) as ice-rich soils warm.

that relatively deep waters around Greenland will probably warm over the next 90 years at double the rate of deep water globally. The projected impact: Coastal glaciers will melt faster than had been anticipated—largely from below (*SN Online*: 7/6/11). —Janet Raloff



Supercyclones A cloud of air pollution over northern India and surrounding regions has doubled—and occasionally tripled—the intensity of late spring cyclones in the Arabian Sea (2007's Gonu, above) during the last three decades (*SN*: 12/17/11, p. 13).

Up and up Cores taken from North Carolina sediment reveal that sea levels began rising precipitously in the late 19th century and have since tripled the rate of climb seen at any time in the last two millennia (*SN*: 7/16/11, p. 13).

IQ dropper Children exposed in the womb to substantial levels of neurotoxic pesticides have lower IQs by the time they enter school than do kids with virtually no exposure, three studies find (*SN*: 5/21/11, p. 15).

Clothing dangers Plastic fibers from polyester or synthetic fabrics foul coastal environments worldwide (*SN Online*: 9/14/11).

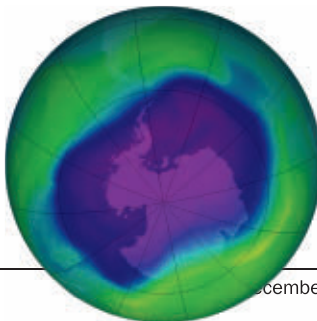
BPA revisited Two new studies link feminized behaviors in adult male mice with exposure during development to the plastics chemical bisphenol A (*SN*: 7/30/11, p. 16). Another study shows that BPA can trigger hormone-responsive gene changes in people (*SN Online*: 8/27/11).

Germier skies Microbes aloft in the atmosphere can catalyze ice nucleation, leading to cloud formation

and bad weather conditions (*SN*: 6/18/11, p. 12).

Immune weeds Research uncovers a rapid rise in herbicide-resistant weeds and increasing numbers of weeds immune to multiple herbicides (*SN*: 7/2/11, p. 5).

Polar ozone Record ozone depletion over the Arctic rivals what was observed in the Antarctic when holes in the protective atmospheric layer first appeared there (*SN*: 11/19/11, p. 11). To the south, scientists see signs of recovery in the Antarctic ozone hole (September 2006, shown below) more than a decade earlier than expected (*SN*: 6/4/11, p. 15).



Missing fish New studies suggest that ecologically valuable predatory fish are rapidly disappearing (*SN*: 4/9/11, p. 28).

Noise woes Sonar exercises at an underwater test range led beaked whales to flee the area. Tagged whales exposed to sounds at about 140 decibels stopped hunting and swam toward the surface (*SN*: 4/23/11, p. 16).

Fishy return Within 14 years of a Mexican marine park in the Gulf of California prohibiting fishing, the total mass of its denizens more than quintupled, a sign of habitat protection's potential (*SN*: 9/24/11, p. 14).

Acid ignorance Juvenile clown fish raised in water mimicking the predicted acidifying chemistry of future oceans appear willing to swim toward a predator-packed reef (*SN*: 7/2/11, p. 12).

Boons and busts via gut microbes

Studying the secret lives of bacteria living in human intestines has yielded some unexpected finds. One study suggests that most humans have one of three different combinations of friendly microbes (*SN*: 5/21/11, p. 14), and another reveals that people's mix of microbes depends heavily on diet. Changing the ratios of nutrients consumed tweaks the composition of the microbial populations in the guts of mice carrying human bacteria, scientists find (*SN Online*: 5/19/11).

Knowing just how to alter the diet to achieve the right mix of microbes may be important for good health, both physical and mental. At least one type of friendly bacteria can send signals from the intestines through the vagus nerve in the neck to influence brain chemistry and change behavior in

mice, researchers report (*SN*: 10/8/11, p. 9). Gut microbes have also been found to convert a type of fat found in meat and dairy products into an artery-clogging chemical, and intestinal microbes may trigger multiple sclerosis, an immune system disorder in which the body attacks its own nerve cells (*SN*: 12/3/11, p. 11).

But even if some bacteria break hearts or turn a body against itself, organisms of all sorts would be in big trouble without them. Mice given antibiotics that kill off their microbes can't fight the flu as well mice that don't take the drugs (*SN*: 4/9/11, p. 14). —*Tina Hesman Saey*

Microbes residing in the human intestine can help digest food or prevent infection; others can be more nefarious.



Bright cats Kittens are engineered with a gene for an antiviral protein that scientists hope will help combat feline immunodeficiency virus (*SN*: 10/22/11, p. 9). The cats also get a gene that makes them glow (above).

Beneficial liaisons Humans may have acquired important immune system genes via liaisons with extinct hominid cousins, the Neandertals and Denisovans (*SN*: 10/8/11, p. 13).

Healthy aging After mining the DNA of a woman who lived to age 115, researchers conclude that she did not lack genetic variants predisposing her to heart disease and other aging-related illnesses (*SN*: 11/5/11, p. 9).

Genetic loophole The occasional switch of a chemical unit in RNA to a slightly different form can cause a cell's protein-building machinery to roll right through a molecular stop sign, a find that violates the central dogma of genetics (*SN*: 7/16/11, p. 8).

More than squirm A new system, named COLBERT for "Controlling Locomotion and Behavior in Real Time," allows researchers to commandeer tiny worms and pick apart behavior cell by cell (*SN*: 2/12/11, p. 14).

Missing DNA, bigger brains Humans may have developed bigger brains, spineless penises and other traits after

losing 510 chunks of DNA, a study suggests (*SN*: 4/9/11, p. 15).

Gene fix A new gene therapy allows direct fixing of DNA. With molecular editors called zinc finger nucleases, scientists correct a mutation in mice that leads to hemophilia (*SN*: 7/30/11, p. 9).

Superbug from drugs

Antibiotics and vaccines helped shape the evolution of a nasty strain of pneumonia-causing bacteria, scientists find (*SN*: 2/26/11, p. 16).

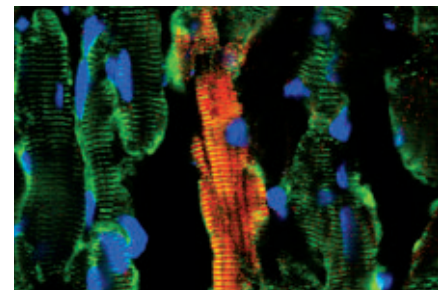
Lager mystery Scientists identify a missing ancestor of yeast used in cold-brewed beer (*SN*: 9/24/11, p. 16).

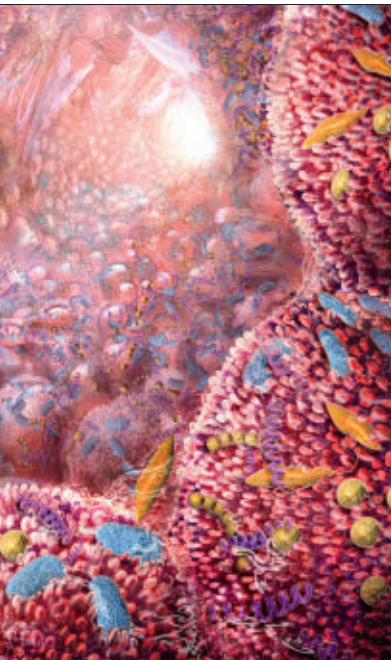
Stem cell steps The body's immune system may attack lab-made stem cells, a study in mice finds, a possible hurdle to using such cells to replace damaged tissue (*SN*: 6/4/11, p. 13). Another study uses human eggs to reprogram adult cells to a

primitive embryonic-like state, but they have extra chromosome sets (*SN*: 11/5/11, p. 8).

Burn that fat Mice lacking a protein that responds to the hunger-promoting hormone ghrelin burn more energy in their brown fat than other mice, hinting at a way to fight obesity (*SN*: 1/15/11, p. 9).

To the heart With a little help from cellular reprogramming factors, skin cells are converted into beating heart cells (*SN*: 2/26/11, p. 16). With some prodding, stem cells lining the outside of the heart can also form new heart cells (red, below) (*SN*: 7/16/11, p. 9).





Pylori trouble A bacterial bad guy responsible for causing ulcers and stomach cancer, *Helicobacter pylori*, may help trigger Parkinson's disease (SN: 6/18/11, p. 18).

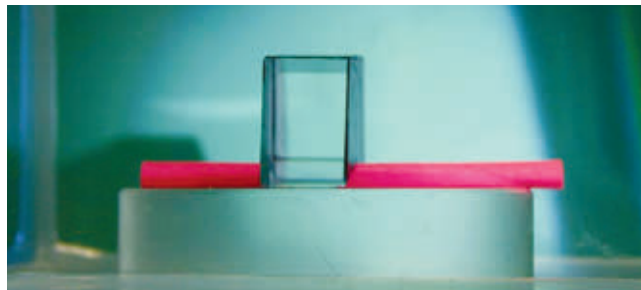
Brain healing Blocking newborn nerve cell formation in mice prevents the animals from learning and remembering in a maze after brain injury, suggesting the newborn cells may help the brain heal (SN: 4/23/11, p. 10).

Gland growth Japanese researchers grow for the first time a mouse pituitary gland from embryonic stem cells in a lab dish, a first step toward replacement glands for people (SN: 12/31/11, p. 15).

Electric eye Cells in a tadpole's gut manipulated to take on specific electrical properties develop into an eye, a major advance toward regenerating complex organs and limbs (SN: 12/31/11, p. 5).

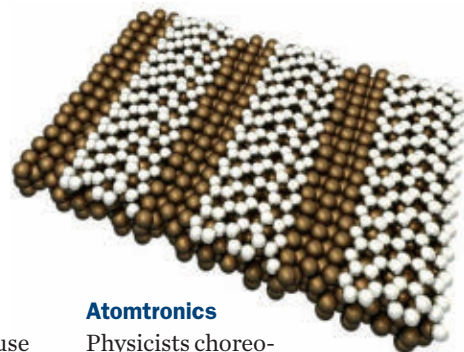
Cosmic mimics Simulations suggest that time travel is impossible in a metamaterial universe (SN: 5/7/11, p. 12), but riding a spacetime bubble could allow travel at up to one-quarter light speed (SN Online: 8/21/11).

Big-time cloaking Teams use carpet cloaks to hide 3-D objects big enough to see (pink paper cloaked below), moving invisibility beyond the microscopic (SN: 2/26/11, p. 12). Physicists also find ways to hide events in time (SN: 8/13/11, p. 12) and to shield objects from detection by visible light (SN: 8/27/11, p. 16) and sound waves (SN Online: 6/30/11).



The next graphene

Scientists grow atom-thin sheets of silicon (nanoribbons at right), with a structure similar to that of graphene (SN: 4/23/11, p. 14).



Sexual fireworks A mouse egg explosively releases zinc atoms just after fertilization, outbursts that appear to jump-start embryonic development (SN: 6/4/11, p. 12).

Wave of reality The fuzzy quantum shape that describes the speed or location of a single particle, its "wave function," is directly measured in the lab (SN: 7/16/11, p. 14).

Atomtronics

Physicists choreograph atoms in an ultracold gas to flow as a controllable current, a step toward building the world's first "atomtronic" device (SN: 3/12/11, p. 5).

Hydrogen head shot The lightest atom on Earth is directly imaged for the first time (SN: 3/12/11, p. 13).

Magnetricity A current of "magnetricity" is created, as north and south magnetic poles split and move independently (SN: 3/12/11, p. 13).

Screw symmetry A new form of symmetry called "rotational-reversal" symmetry is discovered (SN: 5/7/11, p. 9).

Quantum theory gets physical

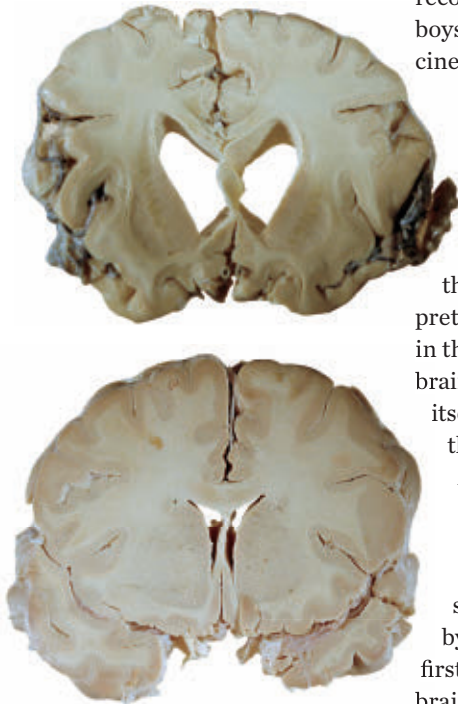
Reality can be understood not only in terms of the flow of energy, but also in terms of the flow of information. So says a team of physicists with a new take on quantum theory (SN: 8/13/11, p. 12). This theory, which explains how matter behaves at the atomic scale, is built on abstract mathematical formulations that seem to defy common sense. But the new take begins with intuitive principles connected to the physical world.

At the idea's core is a postulate called "purification." In simplest terms, purification means that you can know everything there is to know about something even if you don't know everything about its parts. Using this postulate and five axioms drawn from information theory, the researchers have derived the basic mathematical framework of quantum mechanics. The framework also predicts phenomena routinely observed in the lab—including entanglement, Einstein's "spooky action at a distance."

This recent approach to quantum theory is part of a larger movement, inspired by the late physicist John Wheeler, to try to recast the explanation of the universe in terms of information. Proponents speculate that their ideas could ultimately solve one of the grandest problems in physics itself: how to unite quantum mechanics and gravity. —Devin Powell

1/2 | Fraction of adult men carrying HPV

Against Alzheimer's Data link antidepressants to less of the ominous brain plaque associated with Alzheimer's (*SN*: 9/10/11, p. 5). Other studies scrutinize A-beta's role in the disease (unhealthy brain top, healthy at bottom).



Stent risk Brain stents used in patients at risk of stroke may do more harm than good: A study finds rates of death and stroke are higher among patients who receive the device than those who receive an aggressive course of medications alone (*SN*: 10/8/11, p. 14).

Malaria vaccine African children who received the first vaccine against malaria to undergo wide-scale testing are about half as likely to come down with the disease over a 14-month period as those who didn't receive the vaccine (*SN Online*: 10/19/11).

HPV for men A study of men in North and South America finds that half carry human papillomavirus, known for causing cervical cancer in women (*SN*: 3/26/11, p. 12). The U.S. Advisory Committee on Immunization Practices recommends that preteen boys receive the HPV vaccine (*SN Online*: 10/26/11).

Ch-ch-ch-changes

By charting the brain's genetic activity from before birth to old age, two new studies reveal that all human brains use pretty much the same genes in the same way and that the brain continually remodels itself in predictable ways throughout life (*SN*: 11/19/11, p. 5).

Dream deciphered

The contents of a person's dream are revealed by a brain scan for the first time. Monitoring the brain of a man who has unusual control over his dreaming brings researchers closer to understanding how the brain spins its nightly yarns (*SN*: 12/17/11, p. 10).

Cell phone vibes

A 50-minute call boosts activity in brain regions near the ear where a cell phone is located, research suggests (*SN*: 3/26/11, p. 13).

Brain on z's Electrodes implanted in the brains of rats kept up four hours past their usual bedtime show that some cells go to sleep while others remain active (*SN*: 5/21/11, p. 9). Two other studies in fruit flies confirm

that sleep plays a central role in solidifying memories and preparing the brain for new learning (*SN Online*: 6/23/11).

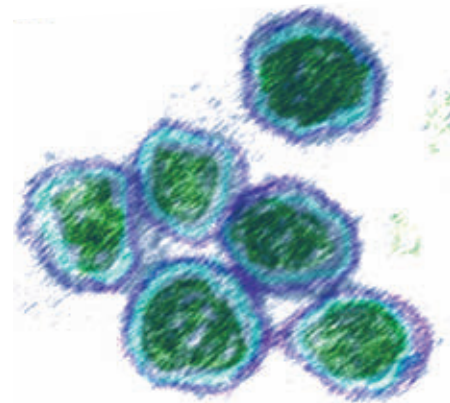
Armadillo infector People infected with leprosy in the United States often have the same previously unknown strain of the microbe *Mycobacterium leprae* that is carried by armadillos, strengthening a long-held assumption that armadillos can infect people directly (*SN*: 5/21/11, p. 9).

To the brain A single drug might create a temporary opening in the blood-brain barrier, allowing for new medicines to treat neurological diseases (*SN Online*: 9/13/11).

Heart tracker Studies suggest that a blood compound called cardiac troponin T could serve as a risk indicator for heart disease (*SN*: 1/15/11, p. 14).

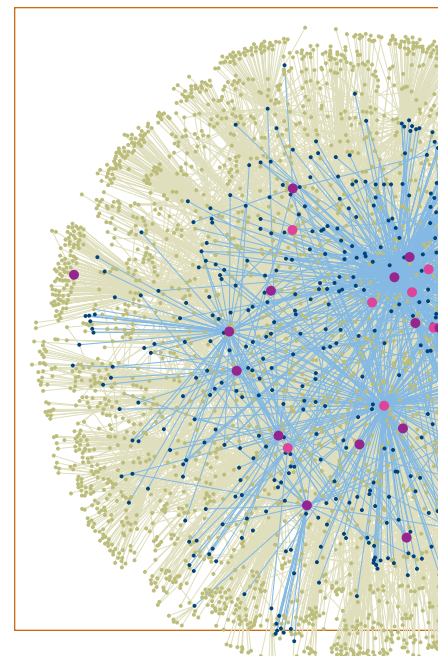
NSAID risk The popular anti-inflammatory drugs ibuprofen and naproxen could contribute to the risk of miscarriage when taken early in pregnancy, researchers find (*SN*: 11/5/11, p. 14).

Degrees of good A study suggests that levels of HDL, the good cholesterol, may not be the most important factor in protecting against clogged arteries and cardiovascular disease; HDL's efficiency at removing fats is a better predictor of who will develop heart disease (*SN*: 2/12/11, p. 16).

**XMRV exonerated**

A study fails to confirm a link between chronic fatigue syndrome and a family of viruses that includes XMRV (above). Nine labs — including the two that originally identified the connection — could not reliably detect the viruses in blood cells from patients with the mysterious and controversial condition (*SN*: 10/22/11, p. 5).

New tubes Blood vessels grown using human cells as factories pass a test in baboons and dogs, suggesting that natural-tissue vessels



THIS PAGE, FROM TOP: DR. GOPAL MURTI/VISUALS UNLIMITED, INC.; © MAGGIE STEEBER/NATIONAL GEOGRAPHIC SOCIETY, CORBIS; CHAD SHAW, BRIAN DAWSON, YASUNARI SAKAI, H. ZOGHEI

could be produced for kidney dialysis or heart bypass surgery (*SN*: 2/26/11, p. 11).

Ketamine explained

The anesthetic ketamine fights depression by quickly boosting levels of a brain compound that has been linked to the condition (*SN*: 7/16/11, p. 17).

Preterm aftereffects Infants born prematurely face a higher risk of dying in early adulthood than babies born at full term, scientists report. The higher mortality risk also shows up when the babies are preschool age (*SN Online*: 9/20/11).

Two brain slots Like side-by-side computer RAM cards, the left and the right hemispheres of the brain store information separately, helping explain why people can remember only a handful of objects at one time (*SN*: 7/30/11, p. 10).

Rerouted for feeling

Amputees whose sense of touch was rerouted from their missing limbs view their prosthetics as part of the body (*SN*: 2/26/11, p. 10).

Apnea-dementia link

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 (*SN*: 9/10/11, p. 16).

Immune booster calms

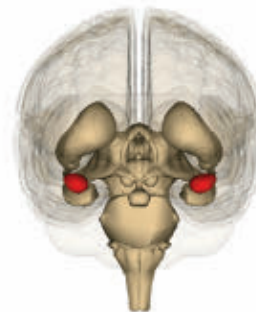
An immune protein once pursued as a treatment to rev up the body's defenses, interleukin-2, may be able to halt or reverse aberrant immune reactions where standard treatments have failed (*SN Online*: 11/30/11).

Breast cancer drug A drug called exemestane, which inhibits the manufacture of estrogen, can lower the



likelihood of breast cancer among healthy women at risk of developing the disease (*SN*: 7/2/11, p. 16).

Supermemory People who can remember every day of their lives in detail have more bulk in certain brain regions, one of which has been linked to obsessive-compulsive disorder (*SN*: 12/3/11, p. 9).



Hypnosis confirmed A glassy gaze that jumps around in bizarre patterns may be a foolproof sign of a hypnotic trance (above), researchers report (*SN*: 12/17/11, p. 10).

Between the ears

The high-pitched ringing, squealing, hissing, clicking, roaring, buzzing or whistling in the ears that can drive tinnitus sufferers crazy may be a by-product of the brain turning up the volume to cope with subtle hearing loss (*SN*: 11/5/11, p. 14).

No fear here A rare genetic disease that destroyed a middle-aged woman's amygdala (red at left) made her immune to fear, researchers find (*SN*: 1/15/11, p. 14).

Sifting through autism's tangled web

Each person with an autism spectrum disorder has a different disease, yet some commonalities exist, a flurry of studies reveals (*SN*: 8/13/11, p. 20). Though the finds don't point to a clear cause or a cure, they inch researchers closer to a deeper understanding of the baffling disorders.

By sifting through genetic differences in a large group of children, researchers find numerous changes that could contribute to autism spectrum disorder (*SN Online*: 6/8/11). Screening more than 1,000 families, including parents and unaffected siblings, reveals dupli-

cated and missing portions of DNA. Such changes may account for 5 to 8 percent of autism cases.

Other research has focused on gene and protein activity in a person with autism. Hundreds of genes behave differently in the brains of people with autism (*SN*: 6/18/11, p. 5), and many of these genes are involved in nerve cell communication. Proteins that govern nerve cell behavior are probably important for the disorders too: Scientists have discovered new relationships between some key autism-related proteins and over 500 other proteins.

Although this laundry list of biochemical changes seems dauntingly complex, the results still represent a flood of progress in trying to understand autism, says child psychiatrist and geneticist Matthew State of Yale University School of Medicine. "These are all, in their own way, making a chink in the armor." —*Laura Sanders*

Proteins known to be related to autism (pink and purple) have been linked with over 500 proteins that may be involved, newly found (blue) and old (tan).



Irish bears DNA analysis suggests that all of today's polar bears can trace their maternal ancestry to a female brown bear in Ireland. Polar bears interbred with brown bears in or near Ireland between 20,000 and 50,000 years ago (SN: 7/30/11, p. 5).

Unexpected farmers A social amoeba, *Dictyostelium discoideum* (spore-forming structure below), practices simple agriculture in the form of bacterial husbandry (SN: 2/12/11, p. 11).



Gone fishing Orangutans in Borneo dine on stranded fish, occasionally jabbing at them with sticks to get them to flop out of the water (SN: 5/7/11, p. 16).

Elephants divided A genetic analysis of elephants and their extinct relatives shows that forest-dwelling African

elephants are a separate species from Africa's savanna elephants (SN: 1/15/11, p. 16).

Eyespots have it Research reveals that more peacock eyespots might not always win a mate, but peahens appear to expect a threshold number before they are willing to get their game on (SN: 5/21/11, p. 10).

Cycad rewrite Today's cycads, once touted as survivors from dinosaur times, turn out to be mostly recent species, diversifying from an ancestor that flourished around 12 million years ago (SN Online: 10/21/11).

Baboon boss stress Top-ranking male baboons generate surprisingly high levels of stress hormones, a sign that these primates pay a cost to be the boss (SN: 8/13/11, p. 11).

Fungus killer A systematic test with initially healthy

little brown bats shows that the fungus *Geomyces destructans* is the primary cause of white-nose syndrome (SN: 12/3/11, p. 12).

Plant rewards In one of the biggest underground markets on the planet — nutrient trading between plant roots and fungi — good suppliers get rewards and bad ones get less business, researchers find (SN: 9/10/11, p. 15).

Diving spiders The air bubbles carried by Eurasian diving bell spiders (below) can act as physical gills, pulling oxygen from the water (SN: 7/2/11, p. 14).



Multicellular life from a test tube

In less than two months, yeast in a test tube evolved from single-celled life to bristly multicellular structures. The new, snowflake-like forms act like multicellular organisms, reproducing by splitting when they reach large sizes and evolving further in response to harsh conditions, William Ratcliff of the University of Minnesota, Twin Cities reported in Norman, Okla., at the Evolution 2011 meeting (SN: 7/16/11, p. 11).

To create pressure to evolve in the experiment, Ratcliff and his colleagues subjected tubes of yeast in liquid to a daily ordeal: a mild spin in a centrifuge and then removal of all but the sludge with the heaviest yeast. Yeasts reproduce by budding, and cells that continued clinging to their daughter buds after cell division probably landed in the sludge and survived. Under pressure from these daily tosses, yeast lineages started holding onto buds that had themselves budded, creating multicelled spiky shapes.

Additional data revealed that the snowflakes amount to more than one-celled microbes known to cluster or form films, suggesting that multicellularity may arise more readily than previously thought, the researchers argue. —Susan Milius

Connecticut cat A cougar took a 2,000-mile journey from the Black Hills of South Dakota to the green lawns of southern New England (SN: 8/27/11, p. 5).

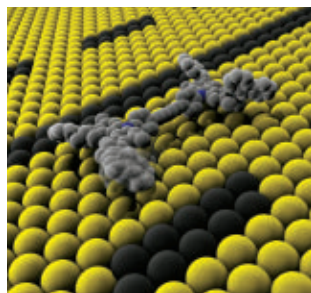
Mice boom A syndrome that has wiped out swaths of aspens across the western United States is linked to an increase in disease-carrying deer mice (SN: 1/29/11, p. 15).

Evolutionary dawdling The last common ancestor of all living animals probably arose nearly 800 million years ago, scientists report — suggesting animals started evolving roughly 200 million years before what's known as the Cambrian Explosion (SN: 12/31/11, p. 12).

Electric sensibilities The dolphin is the first true mammal found to detect electrical fields, via organs thought to be long-lost whiskers (SN: 8/27/11, p. 12).

Stress goes on Not only do zebra finch nestlings dosed with stress hormones tend to die early, but the nestlings also pass the risk of a shortened life span on to future long-term mating partners (SN: 9/24/11, p. 14).

Engineered release Lab mosquitoes infected with a bacterium that renders them unlikely to pass along dengue mate well enough with wild populations to make the bacteria widespread, field tests in towns in Australia reveal (SN Online: 8/24/11).



Tiny test drive A miniature roadster (above) with four molecular wheels and a carbon-based frame rolls across a surface when zapped with electricity (SN: 12/17/11, p. 8).

Virtual princess A team unveils a 3-D holographic video that plays at 15 frames per second, displaying a real-time projection of a grad student dressed as Princess Leia (SN Online: 1/26/11).

No batteries A prototype sensor produces enough electrical charge when flexed mechanically to transmit a wireless signal several meters. Such sensors may help monitor the strength of a bridge, for example, while getting power from the vibrations of trucks rumbling overhead (SN: 7/30/11, p. 18).

Do the twist A new way to mold radio waves into spirals could let multiple radio stations broadcast at the same frequency (SN: 8/27/11, p. 16).

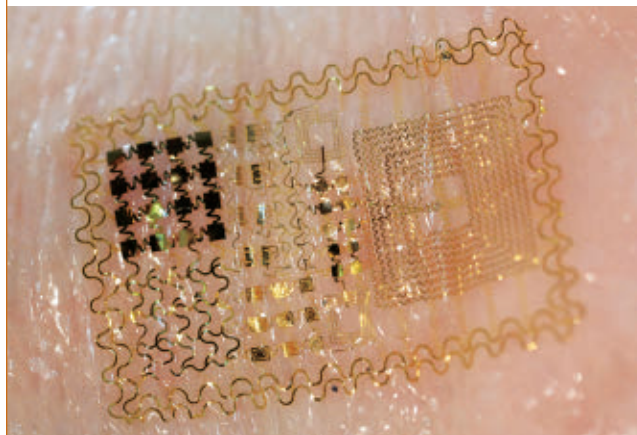
Built for speed A robot that curls itself into a loop and peels out at speeds faster than half a meter per second has been created (SN: 5/21/11, p. 10).

Epidermal electronics

Scientists have created an ultrathin electronic device that puckers, stretches, wrinkles and bends just like human skin (SN: 9/10/11, p. 10). This flexible patch could one day allow the human body to enter the digital world, enabling Internet browsing without the mouse or communication without words. The patch's electronics form a flexible net of wavy S-shaped curves that can stretch in any direction and still work. Two supple polymer sheets sandwich the business layer of the gadget and the whole thing sits on a film that sticks to skin.

Developed as less obtrusive health monitors, versions of the device have been used to track vital signs. In a more lighthearted demonstration, the patch analyzed a person's throat muscles as directions were spoken to move a cursor in a computer game. Mixing and matching electronic components could lead to a variety of jobs, says study coauthor John Rogers of the University of Illinois at Urbana-Champaign. "Creative folks out there will think of things we haven't even contemplated." — *Laura Sanders*

An electronic device sticks to skin like a temporary tattoo, connecting the body to the electronic world.



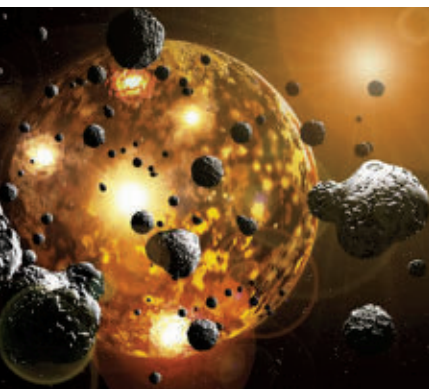
'Stiltskin science In a feat that puts Rumpelstiltskin to shame, researchers spin a multitude of hi-tech materials into superfine nanowire bundles 1,000-plus meters long (SN: 7/16/11, p. 16).

Fix thyself A new lithium-ion battery capable of healing itself may improve the

life span and safety of today's energy-storage technologies (SN Online: 2/21/11).

Follow the flies Mimicking how some developing nerve cells in flies pick a leader has led to a computer algorithm that could make wireless sensor networks more efficient (SN: 2/12/11, p. 13).

230 million years | Age of “dawn runner” fossil



Riches from on high Many of the precious metals mined today were delivered via a bombardment of stony meteorites (illustrated above) that pummeled the Earth and left craters on the moon billions of years ago (*SN: 10/8/11, p. 11*).

Chiseled from below

Molten material rising from beneath is chiseling chunks of rock off the bottom of the Colorado Plateau, possibly explaining why this area has lifted upward over millions of years (*SN: 5/21/11, p. 12*).

Record high tie Analyses from NASA and the National Oceanic and Atmospheric Administration rate 2010 as tied with 2005 for the hottest year on record, followed closely by 1998. Others rank 2010 as the second hottest (*SN: 2/12/11, p. 17*).

Waistline growth Ice melting off Greenland and Antarctica has changed the shape of the Earth, making it more bulgy at the equator, scientists find (*SN: 7/16/11, p. 13*).

Tipping point An analysis reveals that a small change in rainfall or other factors can cause an ecosystem to switch abruptly between forest and savanna (*SN: 11/5/11, p. 5*).

Climate meddlers Humans removing trees to work the land put nearly 350 billion metric tons of carbon into the atmosphere by 1850, researchers suggest (*SN: 4/23/11, p. 17*). Another team

argues that Christopher Columbus and other New World explorers may have set off a series of events contributing to Europe's Little Ice Age (*SN: 11/5/11, p. 12*).

Polar flip The occasional swapping of the north and south magnetic poles may be tied to plate tectonics; when landmasses have bunched together, Earth's magnetic field has begun flipping soon after (*SN: 11/19/11, p. 9*).

Quick colonizers Fossils dating to 530 million years ago suggest that Earth's first animals colonized freshwater earlier than thought, soon after diverse forms appeared in marine habitats (*SN: 6/4/11, p. 9*).

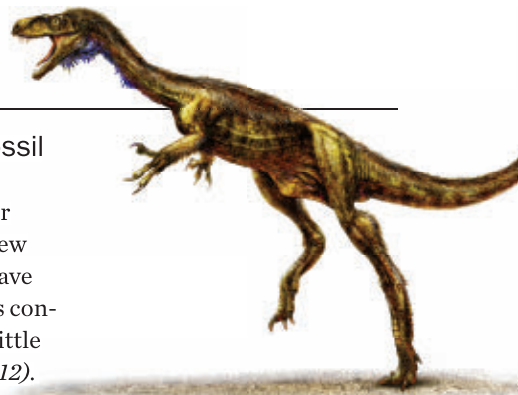
In clusters Researchers argue that Japan's catastrophic March earthquake was part of a spasm of quakes, the second spasm since 1900 (*SN: 5/7/11, p. 5*).

Early meat-eater

Researchers uncover a fossil of a pint-sized meat-eater named *Eodromaeus*, or “dawn runner” (above), that dates to 230 million years ago, the dinosaurs' earliest days (*SN: 2/12/11, p. 10*).

Extinction causes New studies suggest that gassy volcanic eruptions (*SN: 1/15/11, p. 12*) and acidifying oceans (*SN: 10/8/11, p. 10*) could have contributed to the mass extinction at the end of the Permian period, some 250 million years ago.

Big blowup Geologists find evidence for one of the biggest volcanic eruptions ever, in southern Java 21 million years ago (*SN Online: 8/6/11*).



Warming slowdown

The planet's overall temperature has been climbing upward, but that trend stalled during the early 2000s—and now scientists think they can explain why. Several studies suggest that tiny sulfur-rich particles called aerosols, which shield the Earth from the sun's incoming rays, are to blame.

Some of those particles come from volcanic eruptions, such as the Soufrière Hills volcano in Montserrat that has been puttering along since 1995. Although such eruptions aren't as dramatic as the 1991 eruption of Mount Pinatubo in the Philippines, which cooled the whole planet for several years, the aerosols from several small volcanoes are enough to add up to a cooling influence (*SN: 8/13/11, p. 5*). Also playing a role are coal-burning power plants, particularly in Asia. Sulfur particles coming from the plants mostly counterbalanced the warming produced by their carbon dioxide emissions (*SN: 7/30/11, p. 17*).



Soufrière Hills volcano in Montserrat has spit cooling sulfur particles into the atmosphere over the last decade.

Overall, the buildup of carbon dioxide is expected to keep sending temperatures upward—a trend observed by three independent research teams and confirmed this year by yet another analysis performed by the Berkeley Earth Surface Temperature group. —Alexandra Witze

1.76 million years | Age of the oldest known hand axes



While the Han Chinese (top) don't show genetic contributions from Denisovans, Australian Aborigines (bottom) do.

Asia takes a bow

Often overlooked as a geographic player in human evolution, Asia has stepped into the scientific spotlight. New comparisons of ancient and modern DNA indicate that Stone Age humans migrated to Asia in two stages.

At least 44,000 years ago, initial arrivals in Southeast Asia interbred with a humanlike population known as Denisovans that apparently had spread southward from Siberia. Denisovans contributed a portion of genes to living New Guineans (SN: 1/15/11, p. 10), Australian Aborigines and groups on nearby islands (SN: 11/5/11, p. 13). A second human influx gave rise to today's East Asians, with no Denisovan dalliances, starting between 38,000 and 25,000 years ago, geneticist Morten Rasmussen of the Natural History Museum of Denmark in Copenhagen and his colleagues find. The work builds on previous genetic evidence that *Homo sapiens* interbred with Neandertals in West Asia before heading east.

Another study raises the possibility that early members of the genus *Homo* evolved in Asia and then trekked to Africa, not vice versa as many scientists have assumed (SN: 7/2/11, p. 8). *Homo erectus* inhabited a West Asian site called Dmanisi from 1.85 million to 1.77 million years ago, at the same time or slightly before the earliest evidence for the species in Africa, researchers report. — Bruce Bower

Filled belly A 5,300-year-old mummy known as “the Iceman” dined on wild goat before his death in the Italian Alps (SN: 9/24/11, p. 8).

Write stuff Writing down test-related worries before an exam appears to dislodge concerns and lead to higher achievement among high school and college students (SN: 2/12/11, p. 9).

Paint shop In a cave along South Africa's coast, Stone Age humans made a red-hued paint that they stored in abalone shells (below) and possibly used to decorate themselves or their belongings (SN: 11/19/11, p. 16).



Ape to human Skeletal traits in the proposed hominid species *Australopithecus sediba* suggest that the species served as an evolutionary bridge from apelike ancestors to the *Homo* genus (SN: 10/22/11, p. 14).

Fast track Modern humans reached Arabia's eastern edge as early as 125,000 years ago, 65,000 years earlier than generally accepted migrations out of Africa, scientists report (SN: 2/26/11, p. 5).

Hormone's dark side The brain-altering substance oxytocin amplifies whatever social proclivities a person already possesses, encouraging a trusting person to be more trusting but

a suspicious person to be more uncooperative and hostile (SN: 2/26/11, p. 15).

Clovis question Stone tools and flaky rock bits in Texas date to between 13,200 and 15,500 years ago, adding to evidence that the Clovis people were not the first in the Americas (SN: 4/23/11, p. 12).



Easy geometry Mundurucú villagers of the Amazon grasp abstract geometric principles despite having no formal math education, suggesting geometry is innate or learned through general experience (SN: 6/18/11, p. 16).

Built to walk A 3.2-million-year-old fossil from East Africa suggests *Australopithecus afarensis*, best known from the partial skeleton “Lucy,” had stiff foot arches like those of people today, a sign of a two-legged stride (SN: 3/12/11, p. 8).

Oldest axes An East African site yields the oldest known stone hand axes (one at left), dating to 1.76 million years ago (SN: 10/8/11, p. 12).

No poker face People can tell whether a chimp acts dominantly and is physically active just by looking at a picture of its expressionless mug. The ability to discern personality traits via facial structure may have evolved more than 7 million years ago, researchers argue (SN: 2/12/11, p. 8).

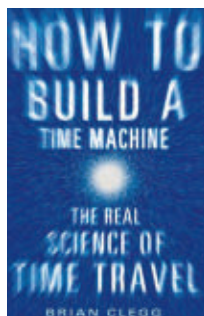
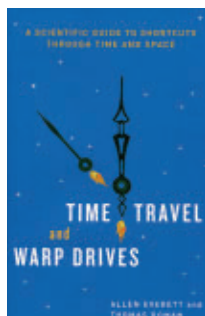
Share or stash If they've worked together to get it, young kids share stuff equally. Adult chimps don't mete out fair shares, suggesting sharing evolved in ancient human foraging groups (SN: 8/27/11, p. 10).

Time Travel and Warp Drives

Allen Everett and Thomas Roman

How to Build a Time Machine

Brian Clegg



As any fan of Doctor Who or Marty McFly can attest, few areas of science excite quite as much public interest as time travel. Step into a police box or a DeLorean, flip a switch, and you're off to change the world — or perhaps save it.

Would-be time travelers now have two new relevant guides to the promise of time machines. Which you might prefer depends on just how much you want to understand the mathematics underlying a machine like the TARDIS.

Surprisingly, time travel is not that difficult in principle; nothing in the known laws of physics prohibits it. The problem is with today's technology.

Take Ronald Mallett, the University of Connecticut physicist who has been trying to build a time machine to visit

his father, who died when Mallett was 10 years old. Using a ring laser, he hopes to generate “closed timelike curves” in which particles can return to the past. Mallett has realized that his machine could take him no further than the time when it was switched on — making a visit with his late father impossible.

Everett and Roman are physicists who have probed the theoretical possibilities of time travel. Their expertise shines as they talk the reader through the underlying math of time travel, much like an introductory college course. These are writers who don't shy away from introducing Lorentz transformations in the third chapter.

In contrast, Clegg's book is more like chatting with fellow students after a professorial lecture. Its breezy summary glosses over some of the finer points of time travel, but allows an excellent entry point for readers less willing to slog through grim mathematical details.

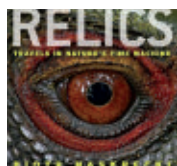
Fascination with time travel is itself timeless; witness the recent excitement over neutrinos possibly moving faster than light. If true, this would also permit the particles to travel backward in time. If that happens, you'll need a handy reference guide. —Alexandra Witze

Everett and Roman: Univ. of Chicago, 268 p., 2011, \$30; Clegg: St. Martin's, 320 p., 2011, \$25.99

Relics: Travels in Nature's Time Machine

Piotr Naskrecki

Some species are survival champs, able to persist for millions of years virtually unchanged. Known as “relicts,” their



long lineages give biologists a glimpse of what life was like before humans could observe it.

Naskrecki, an entomologist and photographer, titled the book *Relics* rather than *Relicts* as a respectful nod to his subjects' status as objects of antiquity. Part travelogue, part natural history, the book chronicles his journeys from rain forest to

Wyoming sagebrush plain in search of these relics. Naskrecki's writing is sincere, enlightening and sometimes genuinely funny, as when he describes his harrowing adventure with bungee jumping in New Zealand or how he received a nasty chomp from a New Guinean possum while a biologist friend stood by and assured him, “these possums never bite!”

But the photographs are the real draw here. Naskrecki gets up close to plants and animals to capture them in vivid, colorful detail. Turning the pages is like turning over rocks in the garden — what crawls out can be startling, or bizarre, but always fascinating. —Allison Bohac
Univ. of Chicago, 2011, 342 p., \$45



Super Sneaky Uses for Everyday Things

Cy Tymony

Put your engineering skills to the test with this guide to building gadgets from common

household items. Andrews McMeel, 2011, 145 p., \$12.99



The Fossil Chronicles

Dean Falk

A scientist who studies brain evolution examines fossil finds—the Taung child and hobbits—that are changing

views of human evolution. Univ. of California, 2011, 259 p., \$34.95



Frozen Planet

Alastair Fothergill and Vanessa Berlowitz

Journey with four polar denizens—polar bear,

Arctic fox, Adélie penguin and wandering albatross—through seasonal changes in this companion to a BBC television series. Firefly Books, 2011, 312 p., \$39.95



Galileo's Muse

Mark A. Peterson

A physicist and mathematician argues that Renaissance art spurred the scientific revolution that laid the foundations of modern science.

Harvard Univ., 2011, 336 p., \$28.95



An Engineer's Alphabet

Henry Petroski

A selection of quotations, anecdotes and other engineering trivia is arranged into a mini-encyclopedia

of the profession. Cambridge Univ., 2011, 360 p., \$21.99

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Thinking probabilistically

In the excellent article “Beware the long tail” (*SN*: 11/5/11, p. 22), the areas under each curve in the figure “Spotting the tail” should be unity (the total probability must be one). Therefore, the red curve should be lower in the center than the black one.

Filson Glanz, Durham, N.H.

Yes, the area under each curve should add up to one. In this case the graphic was shown without a y-axis to illustrate the basic point about the shapes of such curves; it would have been more appropriate to have shown the curves separately rather than superimposed.
— Rachel Ehrenberg

The graphic “Event prediction” shows the Shanghai Stock Exchange Composite Index starting to decline at the beginning of the predicted period (gray bar) in 2009, but the text states that the bubble burst July 29, two days after the

prediction of July 17–27. What is the explanation?

Bobby Baum, Bethesda, Md.

The graph was reproduced from a paper in the Journal of Economic Behavior and Organization, which misplaced the gray bar for the 2009 prediction. The bar should have been farther to the left, such that the gray area ends right before the index's fall.
— Rachel Ehrenberg

Standardizing the boom

I read your article “Explosive goes boom, not too soon” (*SN*: 10/22/11, p. 10) and had to wonder, why 2,940 grams for the drop test weight? It certainly doesn’t convert to a straightforward number of pounds or ounces.

Paul Johnston, Kamuela, Hawaii

Materials chemist Adam Matzger of the University of Michigan in Ann Arbor

replies: “This is the weight of the 3.5-inch steel drop weight we used. It is not a standard size; in fact, there is not really a standard, so we calibrated our drop weight system against established explosives.”

Greedy monkeys

The research that concludes kids are generous and chimps are not (“Kids share, chimps stash,” *SN*: 8/27/11, p. 10) based on two dissimilar studies makes no sense to me. The children were sharing marbles, the chimps food. Ask a bunch of hungry 3-year-olds to share chocolate chip cookies and see what happens. Then, if they do share, I might believe the children are altruistic and the chimps are opportunistic.

Eleanor K. Summer, Gainesville, Fla.


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American and Dutch physicists reach new low temperature

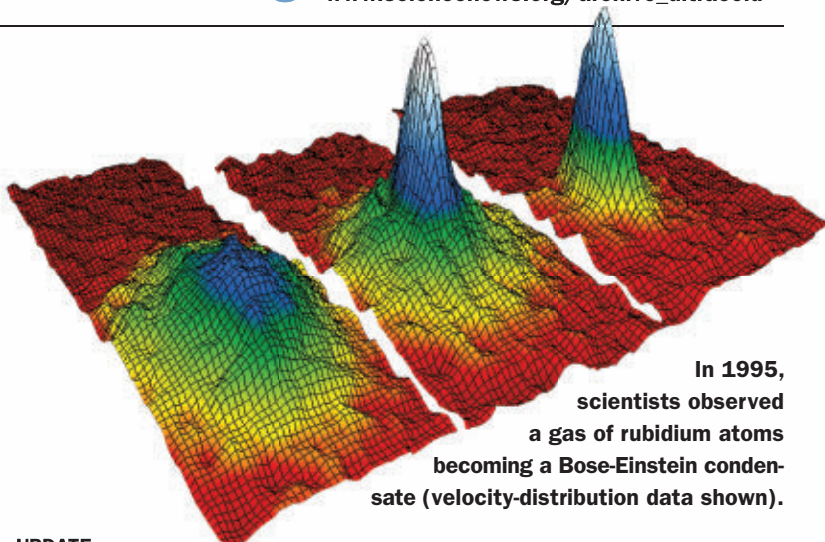
The greatest cold produced and measured by man has now been pushed to within a quarter of a degree of absolute zero, that unattainable heatless point where all motion of the molecules cease and where gas would exert no pressure whatever.

Two groups of research workers, one at the University of California and the other in Holland, using novel methods identical in principle, have arrived at the extraordinary low temperatures of 0.25 degrees absolute and “certainly below 0.27 degrees absolute,” respectively.

The University of California scientists are Drs. W.F. Giaque and D.P. MacDougall, while the Dutch scientists are Prof. W.J. de Haas and E.C. Wiersma of Leyden and Prof. H.A. Kramers of Utrecht. The Americans did their work earlier and published first, and so they now hold the record.

Dr. Heike Kamerlingh Onnes, the pioneer in low temperature research who worked at Leyden, Holland, used the method of lowering temperature by reducing the vapor pressure of liquid helium. He reached a temperature of 0.82 degrees absolute and the same method was used by his successor Dr. W.H. Keesom of Leyden last year to attain 0.71 degrees.

The new low temperature records have been made by taking advantage of the fact that when a substance is magnetized, it heats up. Using liquid helium, made by cooling, liquefying, and solidifying of air, and then liquefying hydrogen to cool the helium, a substance is cooled as low as possible. Then it is magnetized. It heats up. Liquid helium is used to remove that heat. Then it is demagnetized, taking care to keep it heat-insulated. It becomes colder as a result of the demagnetization. Thus lower temperatures than ever before attained have been reached. Technically the method is referred to as “adiabatic demagnetization of paramagnetic salts.”



In 1995, scientists observed a gas of rubidium atoms becoming a Bose-Einstein condensate (velocity-distribution data shown).

UPDATE

Physicists keep going lower

The third law of thermodynamics prohibits scientists from reaching absolute zero, but that doesn't stop the competitive among them from trying to get as close as possible.

From the 1930s into the 1990s, *Science News* printed at least three dozen stories on the race to low temperatures, tracking new records as they fell from thousandths of a degree above absolute zero (millikelvins) to millionths (microkelvins) to billionths (nanokelvins).

A big breakthrough came in 1995, when researchers Eric Cornell and Carl Wieman cooled a gas of rubidium atoms to around 20 nanokelvins. As the temperature dropped, a new state of matter appeared. The atoms lost their individuality and began to behave as a superatom. Called a Bose-Einstein condensate, the exotic material had been predicted in the 1920s by Albert Einstein and Indian physicist Satyendra Nath Bose.

The 1995 discovery inspired a flurry of activity in the ultracold field. Scientists rushed in to explore the condensate's bizarre properties and to gain insights into fundamental physical questions. But those efforts didn't derail the race. If anything,

more contestants emerged as scientists began cooling their own chosen stuff in an effort to uncover unusual phenomena.

In 2003, a team led by MIT's Wolfgang Ketterle, who shared the 2001 Nobel Prize in physics with Cornell and Wieman for their ultracold efforts, created a Bose-Einstein condensate of sodium atoms at 450 picokelvins. This year in *Physical Review Letters*, Ketterle and colleagues report cooling what's called a “spin mixture” to a record-low 50 picokelvins (one twenty-billionth of a degree above absolute zero).

And it's not just atoms getting all the attention. Parallel races exist for molecules (*SN*: 12/20/08, p. 22) and for mechanical objects cooled with the touch of light (*SN*: 5/7/11, p. 24). — Elizabeth Quill

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— Johnnie E., Ellijay, Ga

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