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SOCIETY FOR SCIENCE & THE PUBLIC
DECEMBER 28, 2013

25 Top science stories of 2013

OUR EDITORS' PICKS:
Microbes ascendant, lab-grown organs, a better baby picture of the cosmos and more

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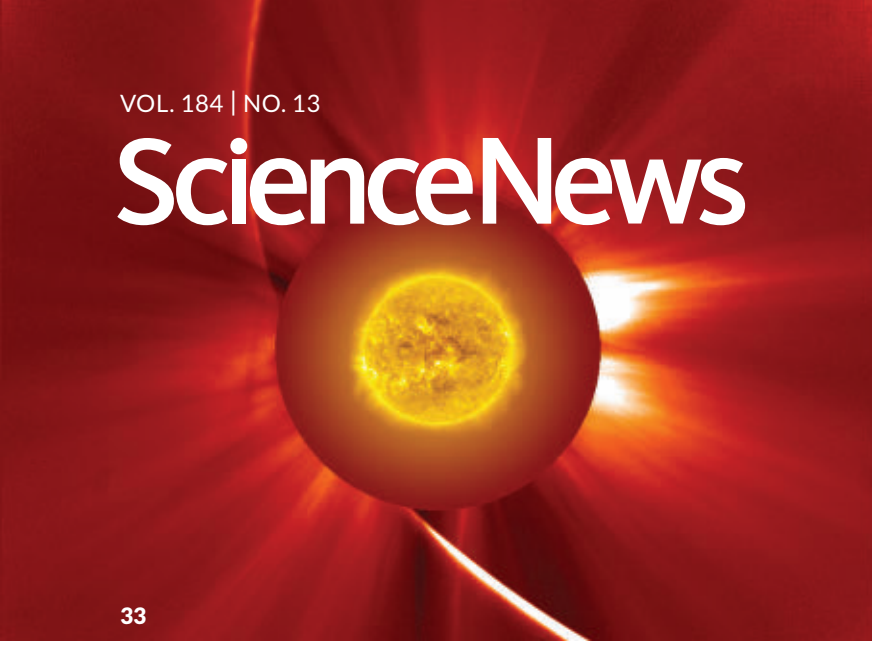

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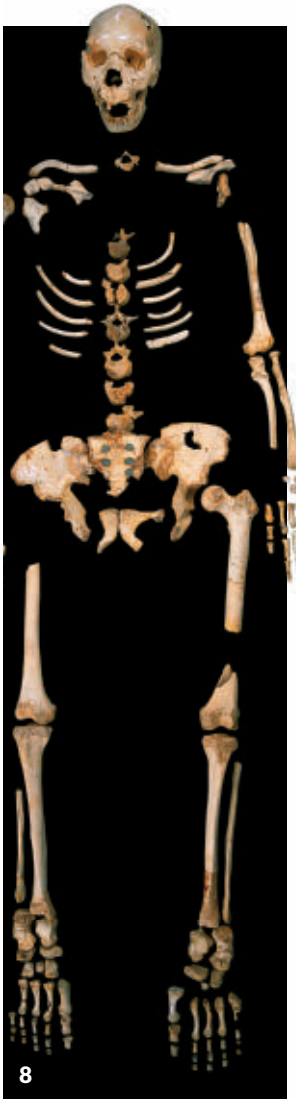

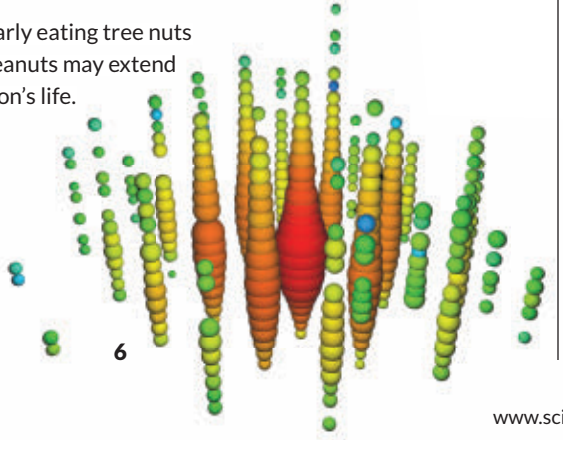

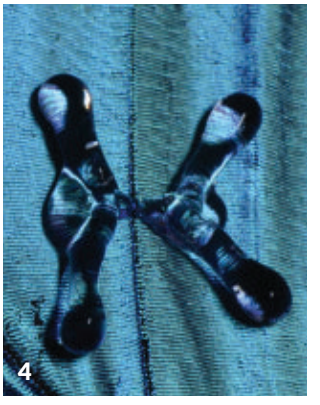

Departments

COVER The central region of an image from the Planck satellite shows a white band of dust marking the Milky Way's plane. *ESA and Planck Collaboration*

CLOCKWISE FROM TOP: SOHO/NASA & ESA, SDO/NASA, FRANCIS REDDY; COURTESY OF ADAM PAXSON, KYLE HOUNSELL, JIM BALES, J. BIRD, KRIPA VARANASI; COURTESY OF THE ICECUBE COLLABORATION; JAVIER TRUEBA/MADRID SCIENTIFIC FILMS

Microbiome emerges as a clear breakthrough

Back in August, when we first began planning this issue's compilation of the top science stories of 2013 (Page 18), there was no shoo-in for the No. 1 spot.

One contender was the creation of functional artificial kidneys and livers in the lab, as well as a kind of simple mini-brain, all grown from scratch (Page 20). These were also among the most-read stories for the year on the sciencenews.org website (Page 38).

Another top candidate was the shuttering of the Planck spacecraft after its successful mission to spy on light that was created just after the Big Bang (Page 21). This ancient radiation, marked by events that took place early in the universe, "just looks like noise, but there is nothing in cosmology that contains more information," says Planck project scientist Charles Lawrence of NASA's Jet Propulsion Laboratory in Pasadena, Calif. Some of the stunning single-frequency sky maps used to assemble Planck's cosmic vistas are included in this issue's Science Visualized (Page 40) and one is featured on the cover. Admittedly, Planck did not produce any major breakthroughs. But it did confirm and add new detail to current understandings of the age, composition and geometry of the universe, as well as to one of the most important events in all of time: the Big Bang. That's historic, if still not quite the story of the year.

Then, as summer turned to fall, we noticed a quiet, nearly incessant buzz about microbes and how they affect the body and health. News pitches from molecular biology writer Tina Hesman Saey about interesting new microbiome studies landed in my e-mail inbox on what seemed a weekly basis. Then life sciences writer Susan Milius got into the act, writing about how microbes in insects may affect the course of the insects' evolution. In the capable hands of former editor in chief Tom Siegfried, who did an admirable job pulling the entire year-end section together, 2013's top story started to take shape.

These past few months have underscored our choice, with Saey adding new bits to the lead story of this issue (Page 19) as new results continued to roll in well into December. Like bacteria themselves, the microbiome story seems small in scale. But added up, it's quite a tale. The various creatures that live in and on us have a powerful, if often invisible, influence on how the body works. In years to come, understanding those influences may provide answers to some of the most enduring mysteries in physiology and medicine, from obesity to autism and autoimmune disease.

— Eva Emerson, Editor in Chief

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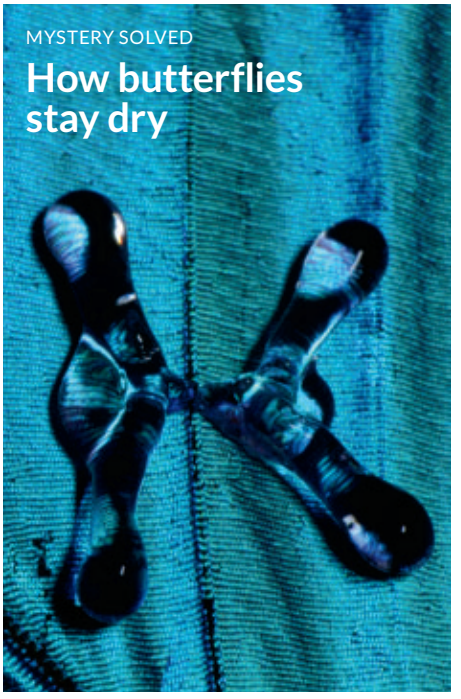
Excerpt from the December 21, 1963, issue of *Science News Letter*

50 YEARS AGO

Cancer Vaccine in Near Future Foreseen

The dream of developing a cancer vaccine will come true, perhaps in the near future.... The whole field of cancer research is "blooming" with a fertility not contemplated even two years ago, Dr. Alexander Haddow of the University of London and the Chester Beatty Research Institute said in Washington, D.C. Perhaps within ten years, he told a meeting of the American Society of Hematology, research in seemingly separate fields will come together and point to the fundamental principle in the formation of body cancers. Then immunization studies can proceed full speed.

UPDATE: Fifty years later, only two types of vaccines are approved in the United States for preventing cancer — one that prevents infection with hepatitis B, which causes liver cancer, and another that protects against strains of the human papillomavirus that cause cervical cancer. Fewer than half of adolescent girls in the United States have been fully vaccinated against HPV.



MYSTERY SOLVED

How butterflies stay dry

So much for rain slickers. Slightly bumpy surfaces, like those of butterfly wings, are better at repelling water than completely smooth surfaces are, researchers report November 20 in *Nature*. James Bird of Boston University and colleagues dripped water onto silicon wafers with different textures and filmed the droplets' splashes. Drops of water striking smooth surfaces flattened into a Frisbee shape before bouncing away. But droplets hitting ridged wafers flared into a splatter that skimmed surfaces only briefly before rebounding. Ribbed textures force droplets to skip off surfaces quickly, cutting the contact time between water and wafer, the authors found. The results help explain why the veined wings of *Morpho* butterflies (left) are so good at staying dry. — *Meghan Rosen*

THE LIST

Unusual new species names of 2013

Siats meekerorum

Newly found fossils of this dinosaur show it was anything but meek, probably terrorizing the ancestors of *Tyrannosaurus rex*.

Cardiocondyla pirata

The pirate ant gets its name from the dark ribbon across females' eyes, resembling a pirate's blindfold for walking the plank.

Cthulhu macrofasciculumque

Found in termite hindguts, this tiny creature with more than 20 flagella is named for H.P. Lovecraft's tentacle-headed demon Cthulhu.

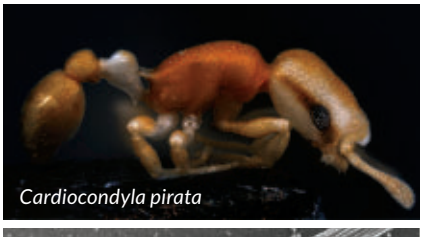
Megachile chomskyi

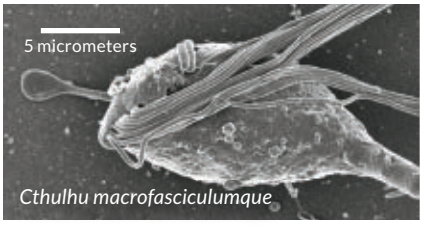
A new leafcutter bee species is named in honor of linguist and philosopher Noam Chomsky.

Bothriechis guifarroi

A bright green pit viper is named for Honduran conservationist Mario Guifarro, who was killed while fighting illegal logging.


Siats meekerorum


Cardiocondyla pirata



Cthulhu macrofasciculumque

BUZZWORD

SCIENCE

2013 Word of the Year

from Merriam-Webster.com

176% increase in lookups over 2012

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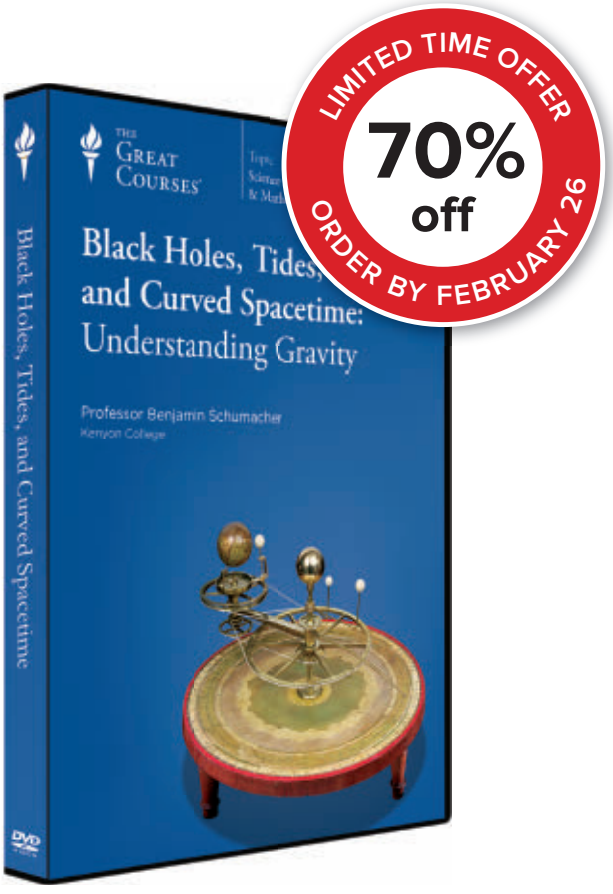

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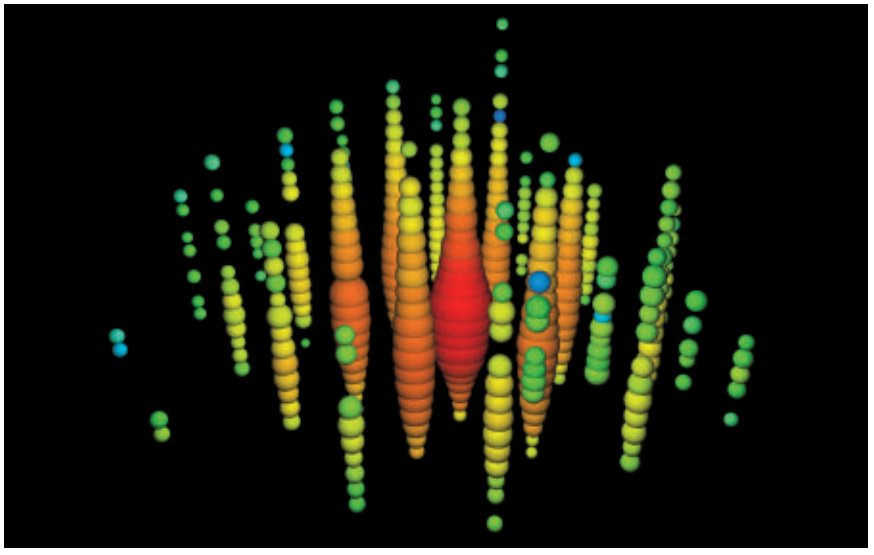
ATOM & COSMOS

Alien high-energy neutrinos detected

Speedy particles may expose unknown cosmic phenomena



The highest-energy neutrino yet observed, dubbed Ernie, carried 1.14 million billion electron volts of energy. Colors show when light triggered by the neutrino hit IceCube detectors (warm colors first, then cool colors).

COURTESY OF THE ICECUBE COLLABORATION

BY ANDREW GRANT

High-energy neutrinos from beyond the solar system have been snagged for the first time by a giant experiment buried under Antarctic ice. The detections represent a major step toward identifying mysterious astrophysical phenomena that hurl subatomic particles across the universe at extraordinary speeds.

Neutrinos are an intriguing tool for exploring the cosmos. The wispy particles have no charge and rarely interact with matter, allowing astronomers to trace a straight path back to their source. However, neutrinos' inertness also makes them hard to detect. Scientists are confident that alien neutrinos packing more energy than particles from any human-made accelerator are constantly pelting Earth, perhaps pointing to some of the universe's most violent objects. But until now researchers had managed to detect only relatively puny neutrinos streaming from terrestrial sources, the sun and a 1987 supernova.

Looking to end decades of frustration, physicists put their hopes in IceCube, a vast array of neutrino detectors buried as deep as 2.5 kilometers beneath the surface of the Antarctic ice sheet near the South Pole. Since May 2010, more than 5,000 light sensors embedded in a volume equivalent to 400,000 Olympic-sized swimming pools have looked for subtle flashes indicating collisions between neutrinos and atoms within the dark depths of the ice.

Now physicists' perseverance has paid off. During its first two years of operation, IceCube captured 28 high-energy neutrinos, including the eight most energetic ever detected, researchers report in the Nov. 22 *Science*. The team filtered out about 200,000 neutrinos that came from the atmosphere, most of which had lower energies and were accompanied by a shower of other particles, to confirm that these 28 originated light-years away. "There's nothing in the solar system that should be producing these," says study coauthor Nathan Whitehorn, a physicist at the University of Wisconsin–Madison.

The two speediest neutrinos, nicknamed Bert and Ernie when they were announced in April, struck the ice with more than a million billion electron volts of energy. That's about 150 times the energy carried by each proton whizzing around the Large Hadron Collider, the world's most powerful particle accelerator. (Continuing the tradition set with Bert and Ernie, the other 26 neutrinos also received Muppet names, including Mr. Snuffleupagus and Dr. Strangepork.)

Even the most sluggish of the 28 neutrinos packed about a million times as much energy as those from the 1987 supernova. "It's really nice work," says Kate Scholberg, a particle physicist at Duke University not involved in the research. "It's been a long time coming."

The next step, Whitehorn says, is using the neutrinos to solve a long-standing cosmic mystery. For decades, astronomers have detected protons, electrons and other charged particles arriving from space at tremendous speeds. Yet nobody knows what object or event could accelerate particles to those energies. The trajectories of charged particles don't point to their sources because they get deflected by magnetic fields. But charged particles can decay into neutrinos, which travel in a straight line. That means the incoming neutrinos collected by IceCube could finally expose the universe's remarkably powerful particle accelerators, which could be supermassive black holes, cataclysmic stellar explosions or unknown explosive objects.

The 28 neutrinos detected so far came from all directions, Whitehorn says, noting that some particles approached from the Northern Hemisphere and traveled through Earth's interior before striking the ice. But more data could eventually point to specific regions of the sky as primary sources. In addition, neutrinos come in three varieties, or flavors, that offer clues to the particles' origins. The early data confirm that IceCube has captured all three neutrino flavors. Now researchers are busy analyzing the last year and a half of data not covered in the *Science* study. ■

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HUMANS & SOCIETY

Oldest hominid DNA muddles family tree

Evolutionary questions emerge about links between European, Asian forerunners to humans

BY BRUCE BOWER

An analysis of the oldest known sample of DNA from a member of the human evolutionary family raises surprising questions about relationships among far-flung populations of ancient hominids.

Researchers extracted a nearly complete sample of mitochondrial DNA from a 400,000-year-old leg bone previously found in a cave in northern Spain. The DNA shows an unexpected hereditary link to the Denisovans, Neandertals' genetic cousins that lived in East Asia at least 44,000 years ago, say paleogeneticist Matthias Meyer of the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany, and his colleagues.

Their report, which quadruples the age of the oldest known hominid DNA, was published December 4 in *Nature*.

The fossil bone was unearthed in three parts, one in 1994 and the other two in 1999. The same site — Sima de los Huesos, or pit of bones — has yielded the remains of at least 28 individuals. Many researchers classify these fossils as *Homo heidelbergensis*, a species thought to have been an ancestor of Neandertals and perhaps *Homo sapiens* as well.

Ancient mitochondrial DNA recovered by Meyer's team raises questions about how genetic ties were forged between *H. heidelbergensis* in Western Europe and presumably later-evolving Denisovans. Mitochondrial DNA passes down solely from mother to child, so the connection would have to flow through an all-female lineage.

"The Denisovan connection is fascinating, but I'm cautious about how to interpret it," remarks paleoanthropologist John Hawks of the University of Wisconsin–Madison. Because so many years and miles separate the Sima and Denisovan populations, it's difficult to determine the population movements and interactions that could have resulted in the shared mitochondrial DNA segments, Hawks says.

Hominid relationships are difficult to pin down partly because so few bones are available. The Denisovans, for instance, are represented today only by a finger bone and two teeth excavated in a Siberian cave.

Meyer suspects that the Sima hominids belonged to a population that was closely related to both Neandertals and Denisovans. One way the Sima hominids and the later Denisovans could have shared mitochondrial DNA is if the ancestors of each group interbred with members of a third hominid species — possibly *Homo erectus* or an as-yet-discovered species — that contributed the same genetic variants to both groups, Meyer speculates.

Another possibility is that the ancestors of the Denisovans occupied a vast expanse of Asia and Europe before the Sima population evolved, says paleogeneticist Carles Lalueza-Fox of the Institute of Evolutionary Biology in Barcelona. Hominid fossils found in two caves near Sima de los Huesos, dating to between 1.3 million and 800,000 years ago, may represent descendants of that intercontinental population, Lalueza-Fox suggests. Sima hominids thus could have received genetic contributions from those groups that partly matched DNA separately inherited by Denisovans far to the east.

If so, Neandertals probably originated as a small, isolated European population around 250,000 years ago, Lalueza-Fox proposes.

Paleoanthropologist Chris Stringer of the Natural History Museum in London regards the ancient Sima individuals as early Neandertals. Mitochondrial DNA commonalities between the Sima fossil and the Denisovans may have been inherited from well-traveled groups of *H. heidelbergensis*, Stringer says. These genetic sequences could eventually have been lost in Neandertals and modern humans, he hypothesizes, if women who carried the sequences had no surviving female descendants in those two groups.

"We really need nuclear DNA to solve the evolutionary puzzle at Sima de los Huesos," Meyer says. Nuclear DNA, a legacy of both parents, is much more difficult to retrieve from ancient bones than mitochondrial DNA. ■

Hominids living at Sima de los Huesos in Spain 400,000 years ago (one shown) were closely related to later hominids from East Asia, a genetic analysis finds.

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ATOM & COSMOS

Meteorite preserves chunks of Mars' earliest crust

Rock could reveal what the Red Planet's environment was like billions of years ago

BY ANDREW GRANT

Pieces of Mars' original crust have shown up in fragments of a smooth black rock recovered in the Sahara Desert, researchers report in the Nov. 28 *Nature*. The meteorite pieces are among the oldest planetary artifacts ever discovered and could provide insight into surface conditions on Mars during its infancy.

Along with the other planets in the solar system, Mars formed more than 4.4 billion years ago. But you'd never know that by studying meteorites that got blasted off the Red Planet before crash-landing on Earth. Most of the roughly 125 Martian meteorites on record formed less than a billion years ago, providing clues to recent geological activity on Mars but not what it looked like in its youth. The only senior citizen in the Martian collection is Allan Hills 84001, the 4.1-billion-year-old meteorite best known for the discredited claim that it contains fossilized bacteria (*SN: 5/8/10, p. 10*).

Carl Agee, a meteorite researcher at the University of New Mexico in Albuquerque, knew he had something special when a collector gave him samples of a glassy dark stone, nicknamed Black Beauty by a Moroccan dealer who sold it for $50 per gram. In February, Agee and his colleagues reported that they used a traditional method of dating, measuring the ratio of rubidium to strontium, to estimate the rock's age at 2.1 billion years (*SN: 1/26/13, p. 10*).

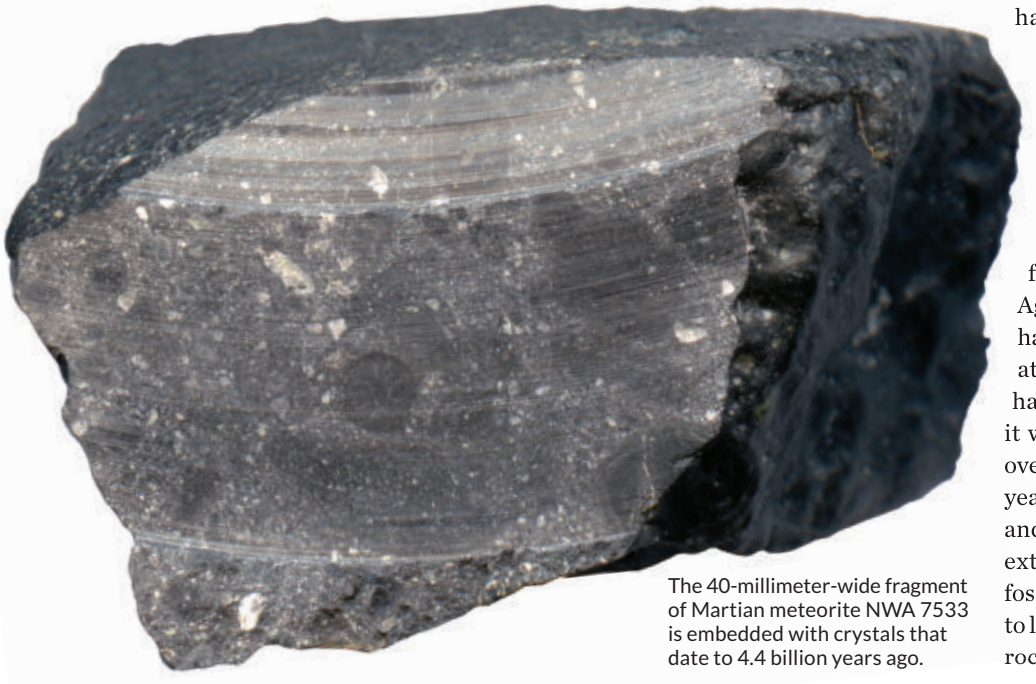
Munir Humayun, a Florida State University geochemist who received a sample from a different collector, decided to dig a bit deeper. He saw that the rock contains small crystals called zircons that form when magma solidifies. He and his team probed five zircons using a technique that measures how much of a particular uranium isotope has radioactively decayed into lead.

> "It's comparable in age to the oldest rocks we know of from the moon and Earth."
>
> MUNIR HUMAYUN

Humayun and colleagues now report that the crystals yielded an age of 4.4 billion years, making the crystals a remnant of the very first Martian crust. "It's comparable in age to the oldest rocks we know of from the moon and Earth," Humayun says. He adds that the fragments could now sell for at least $10,000 a gram.

The finding suddenly shifts the meteorite, officially named both NWA 7533 and NWA 7034 even though Agee's and Humayun's samples came from the same rock, from a record of Martian evolution to an indicator of the planet's initial conditions. Agee, who accepts the older age, reported in the February study that the meteorite contains more than 10 times as much water as any other Martian sample, a strong sign that the Red Planet originally had a tinge of blue. His team also showed that the meteorite is the first with a composition similar to that of rocks analyzed by NASA's fleet of robotic Mars explorers. The crust of the planet's southern hemisphere is much older than the northern crust, yet for some reason scientists have had trouble finding meteorites from the south.

Both Agee and Humayun are investigating individual crystals and grains of the fragments to determine the composition of the primordial Martian crust and of the gases that may have passed through it to form the planet's first atmosphere. Agee says that at that time, Mars may have had the warm temperatures, thick atmosphere and liquid water it would have needed to support life. However, it was also getting pelted by asteroids over a period of hundreds of millions of years, which could have vaporized water and heated the surface to inhospitable extremes. Agee doesn't expect to find fossils, but he says that "if you were going to look for evidence of Martian life, these rocks would be the place to start." ■



The 40-millimeter-wide fragment of Martian meteorite NWA 7533 is embedded with crystals that date to 4.4 billion years ago.

LUC LABENNE

MATTER & ENERGY

Material inspired by dragonfly wings bursts bacteria

Prickly synthetic surface could serve as antimicrobial coating on medical implants

BY BETH MOLE

Tiny spikes on a silicon surface can stab and kill any bacteria that make contact, researchers report November 26 in *Nature Communications*. Designing the feature into coatings on medical devices and food-processing equipment might foil infectious bacteria.

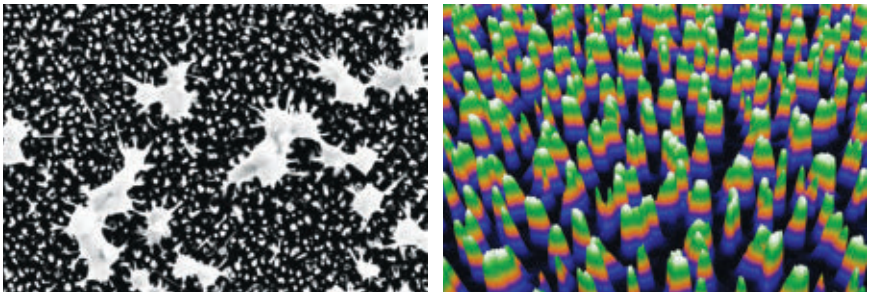
Microbiologist Elena Ivanova of Swinburne University of Technology in Hawthorn, Australia, and colleagues designed the nanoarchitecture by taking cues from bactericidal surfaces in nature such as insect wings. Using scanning electron microscopy, the team discovered that dragonfly wings have protrusions just 240 nanometers tall that appeared to pop bacterial cells that tried to attach to the wing.

By etching light-absorbing black silicon, Ivanova and her team created similar spikes, 500 nanometers tall and just 20 to 80 nanometers thick. Bacteria or bacterial spores exposed to the silicon surface quickly died. On average, each square centimeter of silicon destroyed close to half a million bacterial cells every minute.

Black silicon, which engineers typically use in solar panels and light sensors, is so cheap and easy to manipulate that creating the nanostructured surface takes just five minutes, Ivanova says. The researchers think that nanostructured silicon could coat items such as medical implants to prevent harmful bacteria from hitchhiking into patients.

The coating process "seems pretty straightforward and versatile," says nanochemist Thomas Webster of Northeastern University in Boston. Though Webster would like to see more data on the physical forces that actually cause the bacteria to pop, he says modeling the new material from insect wings is a novel approach for finding ways to kill bacteria. "There's a lot of promise for nanoscale features to reduce bacterial growth without antibiotics," he adds. ■

Nanoscale spikes etched into black silicon (scanning electron microscope image, left; three-dimensional reconstruction, right) mimic nanostructures that are found on dragonfly wings. Both the synthetic spikes and the insect's barbs can destroy bacterial cells.



E. IVANOVA *ET AL/NATURE COMM.* 2013

BODY & BRAIN

Eating nuts may extend life span

Benefits may be tied to cholesterol, inflammation drop

BY NATHAN SEPPA

The already-glowing reputation of nuts is now shining even more brightly: Researchers have linked eating nuts with longer survival. The findings nudge nut consumption a step closer toward the rarified circle of activities shown to fend off the reaper.

The study, the largest to tie nut consumption to longevity, jibes with work showing that the oils and other components of nuts reduce bad cholesterol and possibly inflammation. "If you take the evidence in its totality, the picture being painted by science is quite strongly that nuts improve health," says Cyril Kendall, a nutritionist at the University of Toronto.

The researchers tapped into two long-term studies tracking the diet, health and lifestyle of nearly 119,000 female nurses and male health professionals. The studies' databases include information on deaths during 30 years of follow-up for the women and 24 years for the men. The new analysis accounts for differences in age, sex, race, smoking status, aspirin use, physical activity and other factors.

The scientists found little difference between eating peanuts and tree nuts, with the data suggesting "the more the better" applies to both. People eating scant amounts of nuts had barely better survival rates than people eating none. But those consuming a serving of nuts — at least 28 grams — two to four times a week were 13 percent less likely to die during the studies. Compared with those who ate no nuts, people eating nuts five or six times a week were 15 percent less likely and those consuming seven or more servings per week were 20 percent less likely to die. Ying Bao, a Harvard epidemiologist, and colleagues report the findings in the Nov. 21 *New England Journal of Medicine*.

Longevity seems enhanced by regular physical activity, alcohol in moderation, a diet rich in fruits and vegetables and possibly calorie restriction, studies show. Kendall says that it's too early to add nut consumption as a stand-alone entry to that list, but nuts hold their own as part of a healthy diet.

Bao's team also found that nut consumption was associated with less death due to heart disease and, to some extent, cancer or respiratory disease. ■

LIFE & EVOLUTION

Unusual head shape makes the dwarf seahorse a stealthy predator

Top of snout prevents turbulence from tipping off prey

BY SUSAN MILIUS

A dwarf seahorse can sneak remarkably close to prey — less than a penny's thickness away — thanks to the way its horsey head cuts through the water.

If they had just two or three milliseconds of warning, some of the seahorse's prime prey, tiny crustaceans called copepods, would scoot away, says Brad Gemmell of the University of Texas at Austin. But a dwarf seahorse (*Hippocampus zosterae*) can strike within one millisecond with a sudden pivot of the head.

To succeed with its speedy strike, the dwarf seahorse somehow has to get within about a millimeter of its prey.

New imaging reveals the animal's trick. As a dwarf seahorse head nears prey, a zone of water above the front of the snout tip stays calm, Gemmell and his colleagues report November 26 in *Nature Communications*. The trick fools copepods, which rely on antenna hairs to pick up the whoosh of water in front of an attacking predator.

Ironically, dwarf seahorses are some of the slowest-swimming fish known, yet they can feed on "one of the most capable escape artists on the planet," Gemmell says.

Copepods can shoot away from danger at about 500 body lengths per second — far faster, relatively, than a cheetah, which runs about 20 to 30 body lengths per second. The tiny crustaceans, only a millimeter or two long, cover much less distance. But in their world, millimeters matter.

In calm water, small reef fish called blennies manage to catch the twitchy crustaceans in only about one strike out of three. A dwarf seahorse within striking range succeeds 94 percent of the time, Gemmell says.

"I couldn't do that," he says, even after much experience chasing copepods around lab dishes with a pipette.

The head shape of a dwarf seahorse limits the amount of turbulence the fish makes while sneaking toward unsuspecting prey.

To learn the seahorse's secret, he and his colleagues used a 3-D holography imaging technique based on shining a low-power laser beam at striking animals. Analyzing how the water moved as seahorses skulked toward prey revealed the calm spot just off the tops of the fishes' snouts.

The spot appeared even when the team moved a dead seahorse through the water. It's the shape of the head, and not something the seahorse is doing, that creates the spot, the researchers concluded. ■

BODY & BRAIN

Chemicals kill all stages of malaria

Experimental drugs could treat active and dormant infections

BY BETH MOLE

By striking a critical enzyme in malaria parasites, researchers can defeat the protozoan in all stages of an infection. Compounds kill even those forms of the parasite that hide in the liver or lie low in the bloodstream.

The new battle plan, published November 27 in *Nature*, arrives at a time when malaria parasites are becoming increasingly resistant to drugs. The parasites, protozoans in the genus *Plasmodium*, exist in several distinct life stages within the human body, each of which has different treatment requirements. In the study, scientists could wipe out *P. vivax* and *P. falciparum* — the main causes of malaria in humans — in lab dishes as well as clear other strains of the infection in mice.

The team used chemicals called imidazopyrazines to stymie the malaria by disabling an enzyme in the parasite that controls the transport of lipid molecules across membranes. The enzyme, called PI(4)K, is essential to all of the parasite's life stages.

Elizabeth Winzeler of the University of California, San Diego and her colleagues are tweaking the potential drugs before testing them in humans.

"Now that we found this enzyme, it creates a path forward," Winzeler says of the parasite-killing strategy.

Malaria, which spreads via mosquito bites, can be difficult to treat. Many medications alleviate symptoms without killing all the parasites, Winzeler explains. Infected people may feel better while taking drugs but still carry parasites and spread infection. Parasites can also hide in the liver for years before reemerging.

Winzeler and colleagues had previously found that imidazopyrazines kill some forms of the parasite, but they didn't know if the compounds kill all life stages. After confirming that the chemicals can destroy the parasites in all blood and liver stages, even the dormant liver variety, the researchers tested the molecules in mice. The imidazopyrazines cured infections and protected the rodents from new bouts of malaria.

The work is "a very, very good starting point" for spurring further research on the enzyme, says Jürgen Bosch, a biochemist at Johns Hopkins University. ■

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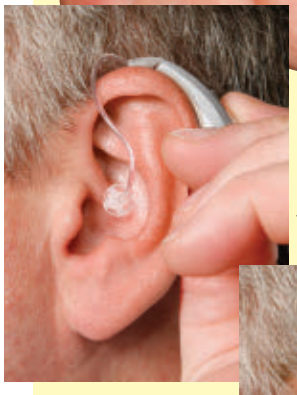

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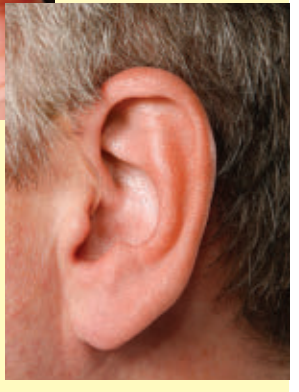

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LIFE & EVOLUTION

Dengue-thwarting mosquitoes fight to take over island in Southeast Asia

Field trial tests insects that could stop spread of viral disease

BY BETH MOLE

Scientists are preparing a second offensive in a biological war against the dengue virus that is being waged on a tiny island in Vietnam.

The virus, which threatens a third of the world's population, spreads by mosquito bites. In April, researchers began releasing dengue-blocking mosquitoes on Tri Nguyen Island. The island is home to around 3,200 people and — for now — dengue, a potentially lethal disease that causes painful fevers. In a November survey, the dengue-proof bugs made up about 65 percent of the island's mosquito population. By December that figure had dropped to 50 percent, but the researchers hope that releasing a second generation of engineered mosquitoes will bring their numbers up to 80 percent. At that point people on the island would be protected from the virus, the researchers calculate.

Most efforts to curb dengue, including experimental vaccines and pesticides, have not been widely successful. Scott O'Neill of Monash University in Clayton, Australia, and his colleagues have worked for more than a decade to develop mosquitoes that thwart dengue virus (*SN: 7/14/12, p. 22*), which scientists estimate infects up to 390 million people annually. The team found that infecting mosquitoes with a group of bacteria called *Wolbachia* lowers or even eliminates the spread of the virus.

The bacteria shove dengue virus out of the mosquitoes' cells, but also weaken the insects, making them more susceptible to stressful conditions such as drought. The bacteria also shorten the mosquitoes' life spans. Elderly mosquitoes with *Wolbachia* visibly tremble and have trouble biting. On Tri Nguyen, they're known as "drunken mosquitoes," O'Neill said. "They look like they're staggering around."

It's unclear whether the insects with *Wolbachia* are surviving long enough on the Vietnamese island to increase their numbers. Infected females pass the bacteria to their offspring. In males, *Wolbachia* alters sperm such that offspring die when an infected male mates with an uninfected female. So infected offspring should begin to outnumber, and eventually replace, uninfected ones, which is what appeared to be happening on Tri Nguyen until the most recent survey.

"While our initial results were quite promising, we are now seeing evidence that this particular *Wolbachia* strain is not spreading into the wild mosquito population as we had hoped," O'Neill said in a December 10 e-mail.

Wolbachia bacteria (large circles) reduce a mosquito's ability to transmit the dengue virus.

S. O'NEILL/WIKIMEDIA COMMONS

In recent field trials in Australia, he and his colleagues tested different versions of *Wolbachia*-infected mosquitoes to evaluate their potential to suppress dengue. The type that the researchers released in Vietnam, which was best at curbing dengue in the lab, failed in the Australian field test. After just a few months outdoors, the mosquito numbers crashed to zero. The team chose to use that version for the initial Tri Nguyen trial anyway because the crash appeared to have been caused by Australia's dry season; Vietnam has wetter conditions.

With the number of engineered mosquitoes now falling, O'Neill and his team are preparing for a second campaign with mosquitoes infected with different *Wolbachia* strains.

But dengue expert Scott Halstead of the Uniformed Services University of the Health Sciences in Bethesda, Md., worries the mosquitoes require more lab work before they will be ready for big field trials like the one in Vietnam. "It's going to take more fiddling," he said.

Starting in April, researchers and volunteers on Tri Nguyen released young mosquitoes with *Wolbachia* in people's homes weekly. Residents, eager to get rid of dengue, agreed to keep cups containing mosquito pupae in 95 percent of the island's 835 houses.

After 23 weeks, researchers had released around 350,000 juvenile mosquitoes. Then the researchers collected mosquitoes every week to monitor the ratio of *Wolbachia*-infected to uninfected bugs.

By September, mosquitoes harboring *Wolbachia* made up around 85 percent of the population and the group stopped releasing more. But then the numbers dipped to around 65 percent in November and 50 percent in early December. O'Neill wasn't surprised by the decline, but if the numbers don't jump back up he has a plan B.

For now he's happy to note that the island hasn't had any dengue cases since the trial began, though the researchers don't yet know whether this is unusual.

Enthusiasm for the approach was high in November, when O'Neill presented an update on the project at the Washington, D.C., annual meeting of the American Society of Tropical Medicine and Hygiene. "It's very exciting," said Laura Kramer, who studies mosquito-transmitted viruses at the New York State Department of Health in Albany. "They've made tremendous progress." O'Neill and colleagues are planning seven other trials across Asia and South America. "We're being inundated with requests," he said.

Even if engineered mosquitoes don't single-handedly stop dengue on the island, they are still a powerful tool, said Thomas Monath of the vaccine company PaxVax, who helped develop a dengue vaccine now being tested. "Dengue control is going to take more than one approach," he said. ■

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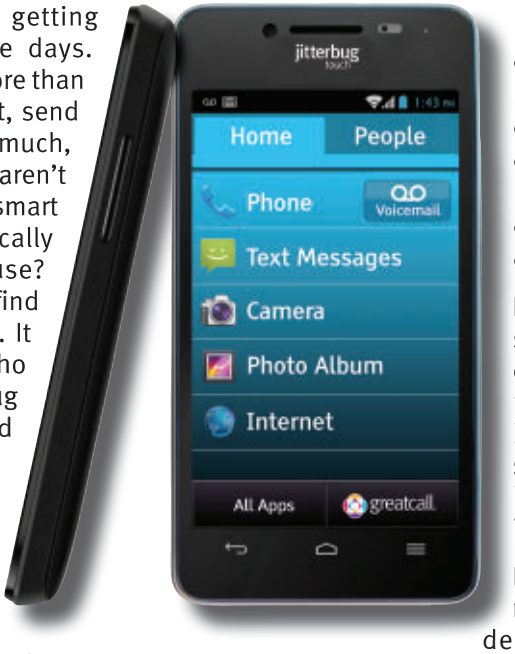

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LIFE & EVOLUTION

Newfound organ gives male koalas their low-pitched voice

Koalas have a newly discovered extra set of vocal cords that allows males to hit notes 20 times lower than expected. The sizes of an animal's voice box and its flapping vocal cords dictate the range of pitches an animal can make, so a typical 8-kilogram koala should sit near the soprano section. But the male's mating call, which to humans sounds like a string of belches and snorts, dips to tones usually made only by elephant-sized mammals. Benjamin Charlton of England's University of Sussex and colleagues dissected the voice boxes of 10 male koalas. They found that the marsupials possess an extra set of vocal flaps outside of the voice box that can make sonorous sounds, the researchers write in the Dec. 2 *Current Biology*. — *Beth Mole*

BODY & BRAIN

Dietary supplements slow HIV progression

HIV-positive people who take multivitamins plus selenium fend off the virus better than those who don't take the supplements, researchers report in the Nov. 27 *JAMA*. For the study, scientists enrolled 878 adults in Botswana who were diagnosed with HIV but hadn't begun treatment. The volunteers were randomly designated to receive a multivitamin plus selenium for two years, selenium alone, a multivitamin alone or a placebo. Compared with the placebo group, those getting the multivitamin-selenium combination fared better. The group was about half as likely to see their levels of key immune cells called CD4 cells drop below a threshold at which a person typically needs anti-HIV drugs. The combination recipients were also about half as likely to develop or die of AIDS as those on the placebo. Alone, neither the multivitamins nor selenium protected against falling CD4 counts or developing AIDS, Marianna Baum of Florida International University in Miami and colleagues report. Selenium and several vitamins are important in immune function. — *Nathan Seppa*

GENES & CELLS

Antibiotics hinder chemotherapy

Gut microbes in cancer patients are necessary for several types of anticancer therapies to work properly, two studies published in the Nov. 22 *Science* suggest. In experiments using mice, antibiotics hampered the ability of two types of anticancer treatments to combat lymphoma and skin and colon tumors, Giorgio Trinchieri of the National Cancer Institute in Frederick, Md., and colleagues report. Immune therapy and platinum-containing chemotherapy drugs called oxaliplatin and cisplatin failed to fight off cancer in mice treated with antibiotics, the researchers found. A separate study from Sophie Viaud of the French National Health and Medical Research Institute in Villejuif shows that a chemotherapy drug called cyclophosphamide causes bacteria in the gut to move into the lymph system. Once there, the bacteria trigger production of immune cells that then kill tumor cells. Mice raised without any bacteria and mice treated with antibiotics couldn't produce as many of these immune cells, and the chemotherapy drug became less effective. — *Tina Hesman Saey*

ATOM & COSMOS

Longevity of Jupiter's Great Red Spot explained

Gases flowing vertically from the top and bottom of Jupiter's Great Red Spot keep the huge storm swirling, according to a new mathematical simulation. No previous work has explained how the mass of swiftly rotating gas has survived for the nearly two centuries that astronomers have observed it. In the new simulation of the cyclone's winds, physicists Philip Marcus of the University of California, Berkeley and Pedram Hassanzadeh of Harvard included both vertical and horizontal gas motion. Previous analyses had either ignored or approximated the spot's vertical winds. With precise vertical speeds included, the Great Red Spot lasted up to 800 years, far longer than it had in any other simulation. The researchers reported the findings November 25 in Pittsburgh at the annual meeting of the American Physical Society's Division of Fluid Dynamics. — *Gabriel Popkin*

JPL-CALTECH/NASA

HUMANS & SOCIETY

Ancient DNA exposes Native Americans' Eurasian roots

An Ice Age skeleton has revealed a genetic link between western Eurasians and Native Americans. The individual may be the earliest modern human to have his genetic portrait painted, and it is entirely different from the picture scientists expected to see. Researchers extracted DNA from a 24,000-year-old arm bone of a young boy found in Mal'ta, near central Siberia's Lake Baikal. Part of the boy's genetic makeup, known as mitochondrial DNA, bears a stamp similar to that of Ice Age and later pre-agriculture European hunter-gatherers. And the boy's Y chromosome looks more like those of today's western Eurasians and Native Americans than like East Asians', Eske Willerslev of the Natural History Museum of Denmark and colleagues report November 20 in *Nature*. Although Native Americans are more closely related to Asians than to people in other parts of the world, the analysis showed that 14 to 38 percent of Native American ancestry may trace to the boy's people. The Mal'ta people probably met up with East Asians somewhere east of Lake Baikal and interbred with them, giving rise to the ancestors of Native Americans. The researchers aren't sure when the mixing began or whether it happened in Siberia or somewhere in North America. — *Tina Hesman Saey*

Microbiome insights add up

Last year it was easy to choose a story to lead our annual Top 25 list. The discovery of the Higgs boson was a watershed moment, ending a decades-long quest by thousands of physicists to fully describe the subatomic realm.

This year, nothing so momentous came to pass. But science isn't just about dramatic announcements and tremendous technical feats. Anyone who reads *Science News* regularly appreciates that great new insights often arise from countless little bits and pieces of new knowledge. This year, careful readers may have noticed a steady accumulation of revelations about the bacterial communities that call the human body home. It has long been known that those microbes are essential to processes like extracting nutrients from food and fighting off their less benign brethren. But this year a growing body of research demonstrated that bacteria engage their hosts so vigorously that in some situations, scientists are left wondering which party is the tail and which is the dog.

Human evolution has also produced an impressive body of new knowledge, though some of it only deepens existing mysteries. For example, the oldest hominid DNA ever analyzed linked 400,000-year-old bones from Spain not to the Neandertals that later dominated the region, but to mysterious early hominids known from sites thousands of kilometers to the east. It will probably be a few more years before anyone can explain what is becoming an increasingly controversial era of human evolution.

This year also demonstrated that big findings can be big letdowns. After a spectacular landing on Mars in August 2012, the Curiosity rover looked for elevated atmospheric methane concentrations that would have been telltale evidence for the presence of microbial life. Anything over a few parts per billion would have given us a clear choice for 2013's top story. But Curiosity detected an average methane concentration of only 0.18 ppb, a finding that landed it in 17th place.

— Matt Crenson, Managing Editor

MARTIN OEGGERLI

Microbiome results argue for new view of animals as superorganisms

By Tina Hesman Saey

We are not alone. Humans' vast inner and outer spaces teem with a menagerie of microbes that stand poised to alter conceptions of what and who we are.

Traditionally, microbes have been viewed as insidious invaders that make people sick or as freeloaders in the human gut. That view is beginning to change. In 2013, scientists amassed substantial evidence that people and other animals form a unit with their resident bacteria, archaea, fungi and viruses — the collection of microbes known as the microbiome. In fact, only about 10 percent of a person's cells are human; microbes make up the other 90 percent.

Many researchers point out that ultimately, every species is out for itself. Nevertheless several new studies argue in favor of considering animals as superorganisms composed of host and microbes. Some scientists even advocate lumping a host organism's genes with those of its microbes into one "hologenome."

Treating a host, such as the human body, and its resident bacteria as a unit — or at least as an ecosystem with intimately interconnected parts — offers various benefits, scientists say. The superorganism approach may help researchers better understand how diet, chemicals and other environmental

View the Top 25 with links to the original stories at **bit.ly/SN_top25**

About a thousand species of bacteria reside in the human gut, some of which are displayed in this hand-colored scanning electron micrograph.

factors affect health, for instance.

Everyone, including identical twins, carries a slightly different microbial mix. Strong evidence indicates that some differences stem from diet or habitat. But even mice raised under uniform lab conditions still have individualized microbiomes. In October, two groups presented research suggesting that host genes play a role in selecting which microbes are allowed to settle in and on the body (*SN: 11/30/13, p. 11*). Immune system genes may be especially important in screening suitable microbial companions.

People with immune system problems have more types of bacteria and fungi on their skin. New research shows that some of those microbes may contribute to eczema-like rashes. That finding supports the idea that the immune system grants visas to friendly microbes while keeping out dangerous interlopers.

Newborns rein in their own immune systems to allow bacteria to take hold, one study found (*SN: 12/14/13, p. 10*). Previously, researchers thought that babies' immune systems were just too immature to control microbes. But the new work shows that in mice and human umbilical cords, blood cells carry an immune-suppressing protein that prevents defenders from fighting off beneficial bacteria.

In mice, pups of stressed moms picked up a different mix of bacteria during birth than those born to non-stressed moms, researchers reported at the Society for Neuroscience meeting in November. Those bacteria may affect early brain development and possibly contribute to disorders such as autism and schizophrenia (*SN: 12/14/13, p. 13*).

A study reported in December may strengthen the link between autism and gut microbes (*SN Online: 12/5/13*). Caltech researchers found that mice with autism-like symptoms have a different mix of gut microbes than normal mice do. Those microbes make chemicals that leak from the intestines into the bloodstream (and perhaps the brain), producing behavioral changes. Treating the mice with the beneficial bacterium *Bacteroides fragilis* improved some symptoms, suggesting that altering the microbial mix might help some children with autism.

Once established, friendly bacteria shield their hosts from harmful invaders and may keep the immune system from overreacting. Harvard researchers discovered that some intestinal microbes make immune-calming molecules that can help reduce the kind of inflammation that afflicts the bowels in diseases like colitis (*SN: 8/10/13, p. 14*).

Even friendly bacteria put their own needs first, though. Another Harvard group found that some strains of a common gut microbe called *Eggerthella lenta* can rob heart patients of a drug called digoxin if the bacteria don't get enough protein from their hosts (*SN Online: 7/19/13*). Some microbes change chemicals in meat into artery-cloggers (*SN: 5/18/13, p. 14*) or cause pain all on their own (*SN: 10/5/13, p. 16*).

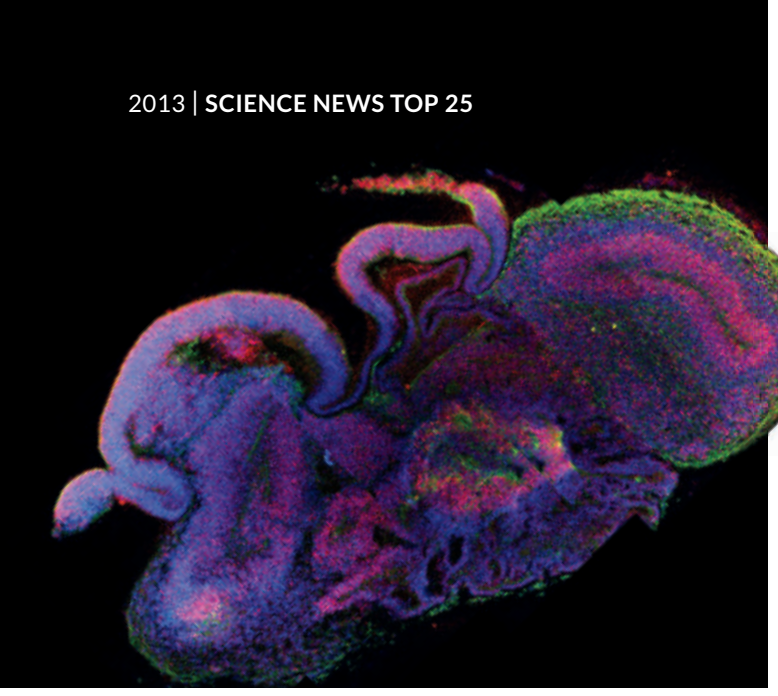
Microbiomes not only alter the biochemical milieu in individuals, but can also influence relationships between entire species. Or even the course of evolution. A study of jewel wasps, for instance, suggests that their microbiomes can prevent two species from successfully breeding with one another (*SN: 8/10/13, p. 13*).

Hybrid male offspring of the two species die as larvae, an effect long explained as incompatibility between the species' genes. But when Seth Bordenstein of Vanderbilt University and his colleague Robert Brucker removed microbes from the hybrid larvae, the wasps survived. That finding indicates that microbes in the wasps' guts and not just the wasp genes contribute to keeping the two species from interbreeding.

10
Percent of cells in the body that are human

90
Percent of cells in the body that are microbes

The microbial momentum continues to build. Ongoing research is sure to find other ways in which microbes and their hosts interact, for good and ill. "It's not just a one-way street," says dermatologist Heidi Kong of the National Institutes of Health in Bethesda, Md. "The microbes are doing something to us and we are doing things to our microbes." ■



A cross section of an immature lab-grown approximation of a human brain reveals neurons (green) and neuron-producing stem cells (red).

2 Bioengineers make headway on human body parts

New techniques produce mimics of brain, liver, heart, kidney, retina

By Meghan Rosen

Baron Victor von Frankenstein would have admired the bounty of body parts scientists crafted in the lab this year.

Lab-grown lumps of liver, bits of brain and clumps of heart, kidney and retinal cells can now mimic the functions of organs grown the old-fashioned way.

Scientists have no plans to assemble a monster, of course. Artificial organs may instead one day help repair or even replace a person's damaged tissues. But that day is still many years away, says retinal cell researcher Robin Ali of University College London. "Making a neuron in a dish is exciting, but it's not a therapy," he says.

In the last few years, researchers have learned how to turn embryonic stem cells into all sorts of different cell types, such as skin cells, heart cells and neurons (nerve cells). These cells are good research tools: Scientists can watch how lab-grown neurons behave in a culture dish and test their responses to drugs.

But to be clinically useful, the cells need to team up and form tissues and organs that researchers can transplant into patients. Getting cells to organize into these three-dimensional structures is tricky. In the lab, cells often stretch out in flat sheets stuck to the surface of a dish.

This year, several research groups tackled the problem using a clever trick: They grew cells in structural scaffolds made of gel or the hollowed-out shells of real organs. The scaffolds can cue cells to grow and give them a physical framework to hook up in three dimensions.

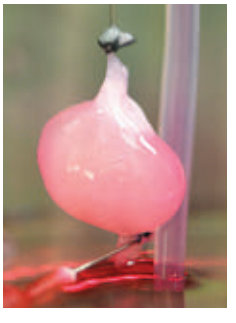
"When cells are bound to just each other, they're very fragile — they will fall apart," says tissue engineer Shay Soker of Wake Forest School of Medicine in Winston-Salem, N.C.

The scaffold technique helped drive this year's bioengineering boom. As part of a recipe to grow human brain tissue, researchers at the Austrian Academy of Sciences in Vienna and colleagues injected stem cells into droplets of gelatinous protein goo. The goo balls grew into primitive brain buds about the size of BB pellets. Neurons inside the buds could mimic some abilities of human brain tissue, such as transmitting electrical signals (*SN: 9/21/13, p. 5*).

Gel scaffolds also helped researchers craft mini-livers from stem cells. After transplantation into mice, the tiny organs could hook up to the blood supply and break down drugs (*SN: 8/24/13, p. 16*). Ali and colleagues used similar scaffolds to transform stem cells into rudimentary retinas. Primitive retinal cells injected into mice's eyes linked up with the optic nerve and developed into mature light-sensing tissue (*SN: 8/24/13, p. 16*).

Gel-based frameworks are good for supporting small clusters of cells, Soker says. But to make bigger clumps of tissue, scientists need to figure out how to re-create the large-scale architecture of organs. This year two research groups took a crack at the challenge by borrowing structures from existing organs.

By stripping the innards from rat kidneys and mouse hearts, and then loading the husks with new cells, researchers bioengineered organs similar to the originals (kidney shown below). The renovated organs could filter waste or spontaneously contract (*SN: 5/18/13, p. 14; SN Online: 8/15/13*).



Still, refilling the shells of organs with fresh cells is like taking an apartment building and swapping out the tenants, Soker says. Eventually, tissue engineers want to erect an entire organ without relying only on existing frameworks. One day scientists may be able to 3-D print these frameworks, or weave them together using technologies from the textile industry, Soker says.

But before people with damaged livers or kidneys receive transplants crafted from scratch, patients might see simpler artificial tissue replacements with lab-grown bone, skin and cartilage, Ali predicts. He thinks these replacements could happen within the next 10 years. Now, he says, "The cutting edge is to work on the biology of transplantation." Safely transferring artificial organs into people's bodies might inspire more than just mad scientists to shout, "It's alive!" ■

FROM TOP: M.A. LANCASTER; OTT LAB/CENTER FOR REGENERATIVE MEDICINE/MASSACHUSETTS GENERAL HOSPITAL

3 Planck refines cosmic history

Satellite hints at slower expansion rate for universe

By Andrew Grant

In October, astronomers said good-bye to the European Space Agency's Planck satellite, breaking off contact with the source of the most precise measurements yet of the universe's oldest light.

Planck had finished its mission to measure the Big Bang's remnant radiation, which today constitutes an invisible bath of microwaves permeating the cosmos. This ancient radiation has cooled over time to less than 3 kelvins (degrees above absolute zero). Its precise temperature varies ever so slightly from point to point across the sky.

With 25 times the sensitivity of its predecessor, NASA's Wilkinson Microwave Anisotropy Probe, Planck was able to identify temperature variations as small as a millionth of a degree. Those temperature fluctuations reflect tiny density differences in the infant universe. As the young universe expanded, matter in the higher-density regions clumped together to form intricate clusters of galaxies.

In March, Planck scientists released data that largely confirmed the standard view of the cosmos and its evolution. An improved estimate for the age of the universe, 13.82 billion years, is slightly older than the previous one but within its range of uncertainty (*SN: 4/20/13, p. 5*).

Planck data also suggested that the universe contains a higher proportion of matter than earlier estimates had indicated — both the ordinary kind of matter found on Earth and the perplexing invisible "dark" variety that affects the motion of galaxies. The probe's wide-angle view of dark matter distribution throughout the cosmos complements underground experiments, such as the CDMS project in Minnesota and the LUX detector in South Dakota, which are designed to identify individual particles of dark matter (*SN: 5/18/13, p. 10*).

Planck also measured a slower expansion rate for the universe than other methods have found. "This is one of the most exciting parts of the data," says Martin White of the University of California, Berkeley.

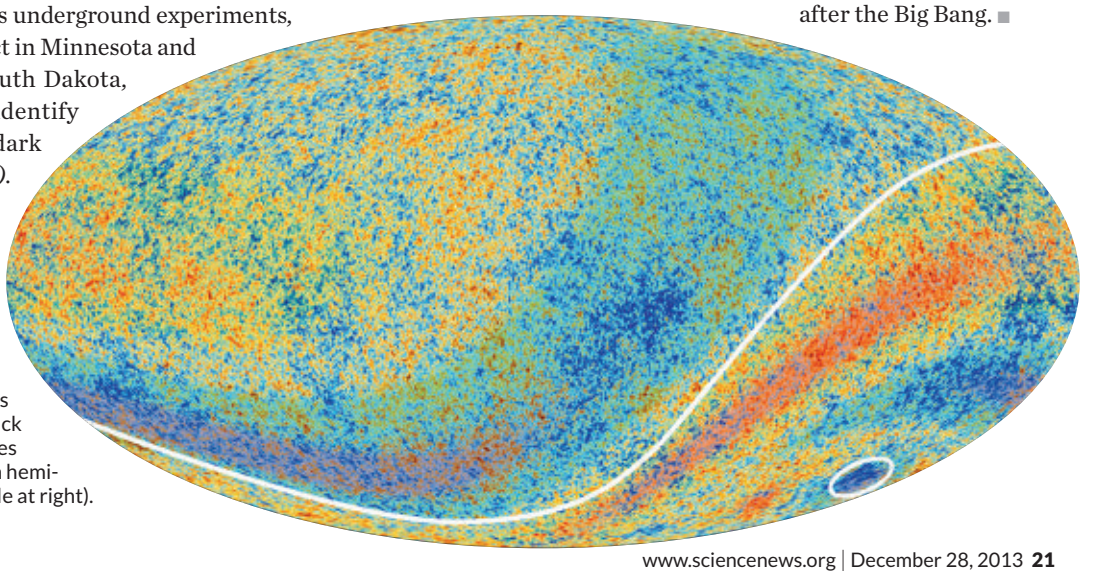
Scientists who measure the brightness of stellar explosions at large distances calculate an expansion rate considerably higher than Planck's. As physicists work to determine how quickly the universe is expanding now, they are also trying to measure whether the strength of dark energy, which causes the expansion rate to accelerate, has changed over time (see Page 31). Such changes would have major implications for understanding what the universe looked like in the past as well as for predicting its ultimate fate.

Planck also confirmed a strange finding by the Wilkinson probe that one side of the sky contains more extreme temperature fluctuations on average than the other. That's a confounding observation, since most experts agree that the universe began as a smooth ball of energy that then expanded uniformly in all directions. Dozens of papers have proposed explanations for the asymmetry, including the possibility that other universes have collided with ours and left behind discernible distortions.

Although communication with Planck has now ended, not all of the satellite's data have been released. Over the next two years, mission scientists plan to produce enhanced maps of the Big Bang afterglow that could provide a window into inflation, a brief burst of extremely rapid expansion of the universe that most experts believe took place in the instant immediately after the Big Bang. ■

13.82 billion years

Planck's estimate for the age of the universe



A color-coded map shows fluctuations in microwave radiation temperature across the sky recorded by the Planck satellite. Noteworthy features include differences between hemispheres and a cold spot (circle at right).

BOTH: ESA AND THE PLANCK COLLABORATION

4

New discoveries reshape debate over human ancestry

Relationships among early hominids disputed

By Bruce Bower

Human evolution appears poised for a scientific makeover, as unexpected and provocative findings have raised new questions this year about two poorly understood periods leading to the emergence of *Homo sapiens*.

The biggest conundrum comes courtesy of the oldest known DNA sample from a member of the human evolutionary family — a 400,000-year-old leg bone previously found in a cave in northern Spain. A nearly complete sample of maternally inherited mitochondrial DNA linked the bone to the Denisovans, mysterious genetic cousins of Neandertals who lived in Siberia at least 44,000 years ago (see Page 8).

Paleogeneticist Matthias Meyer of the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany, and colleagues wrung DNA from a fossil found at Sima de los Huesos, or pit of bones, a site where the remains of at least 28 Stone Age individuals have been excavated. Many researchers classify these finds as *Homo heidelbergensis*, a species regarded as an ancestor of Neandertals and perhaps also of *Homo sapiens*.

It would have been no shock to find mitochondrial DNA links between the Sima fossil and Neandertals, a species that has yielded partial samples of mitochondrial DNA from as early as 100,000 years ago. Now, however, scientists must try to figure out how a genetic connection formed between *H. heidelbergensis* in western Europe and presumably later-evolving Denisovans in Asia.

Several evolutionary scenarios have been suggested. Ancestors of Sima hominids in Europe and of Denisovans in Asia could have mated with members of another humanlike species, such as *Homo erectus*, which transmitted common mitochondrial DNA segments to both populations. Or ancient Denisovan ancestors may have occupied parts of Europe as well as Asia and passed on the same genetic traits to the Sima population and eventually to the Denisovans.

Meyer's team will now try to wrest biparentally inherited nuclear DNA from a Sima fossil in hopes of getting a better look at how evolution played out among populations that set the stage for *H. sapiens*' appearance around 200,000 years ago.

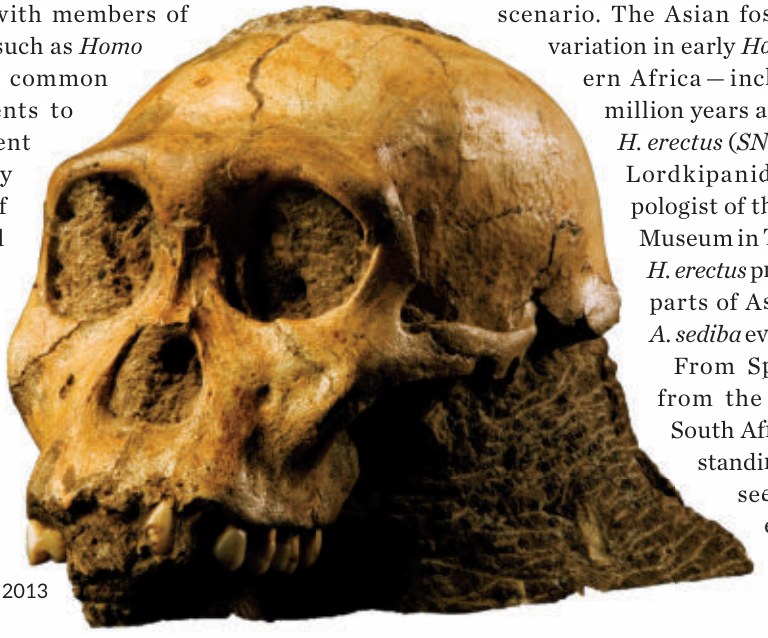
Questions also came up this year about the origins of the *Homo* genus, a group of upright-walking species that led to people today. New analyses of recently unearthed skeletons highlighted opposing views about how the *Homo* line evolved between 3 million and 2 million years ago.

One controversial idea, championed by paleoanthropologist Lee Berger of the University of the Witwatersrand in Johannesburg, South Africa, holds that an odd-looking member of the human evolutionary family living in southern Africa 2 million years ago was the ancestor of the first *Homo* species. Most researchers suspect that the *Homo* genus emerged in eastern Africa.

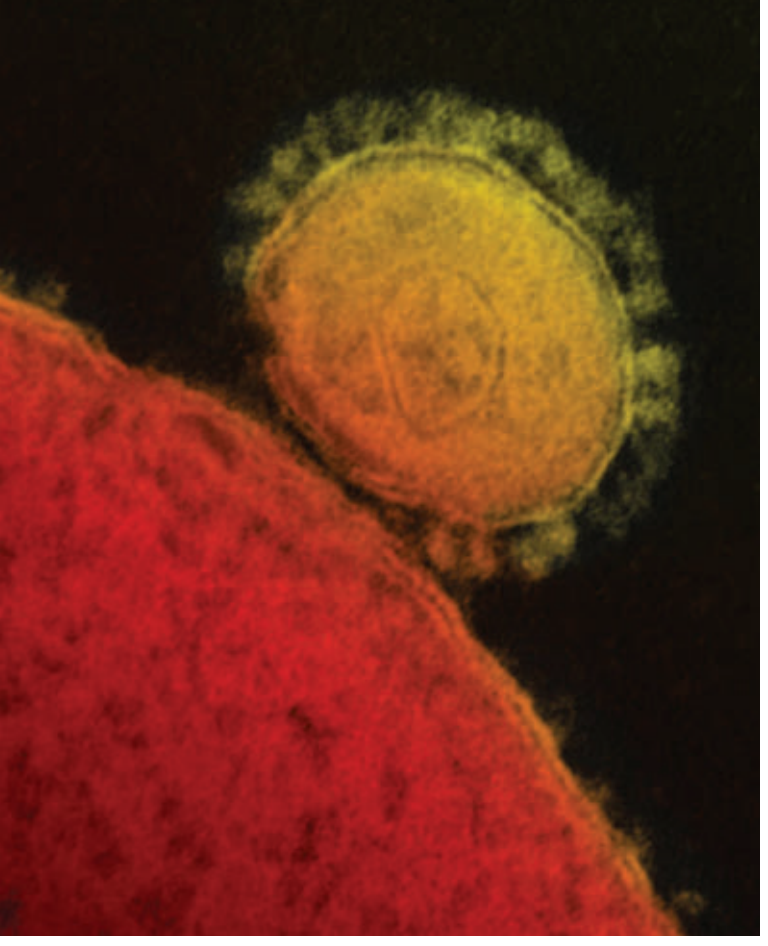
Berger's team studied two partial skeletons excavated since 2008 in a cave at South Africa's Malapa site. These finds come from a previously unknown species, *Australopithecus sediba* (skull shown), that walked on two legs awkwardly and had a small brain (*SN: 8/10/13, p. 26*). The nearly 2-million-year-old Malapa fossils share some key traits with the *Homo* genus, including round brain cases and long, inward-curving lower backs. *A. sediba* could have originated hundreds of thousands of years earlier and evolved into *H. erectus*, a species that also appeared in Africa around 2 million years ago, Berger argued.

But discoverers of a 1.8-million-year-old *H. erectus* skull in western Asia said that the fossil and four other skulls previously found at the same site sink Berger's southern scenario. The Asian fossils display enough variation in early *Homo* fossils from eastern Africa — including one from 2.3 million years ago — also belonged to *H. erectus* (*SN: 11/16/13, p. 6*). David Lordkipanidze, a paleoanthropologist of the Georgian National Museum in Tbilisi, concluded that *H. erectus* probably evolved across parts of Asia and Africa, while *A. sediba* eventually went extinct.

From Spain to Siberia and from the South Caucasus to South Africa, scientific understanding of human ancestry seems poised for some evolution of its own. ■



COURTESY OF L. BERGER/UNIV. OF THE WITWATERSRAND



A transmission electron micrograph shows the coronavirus responsible for Middle East respiratory syndrome in action.

NIAID

5 A double dose of virus scares

MERS, H7N9 join list of potential pandemics

By Tina Hesman Saey

Outbreaks of two deadly viruses captured the world's attention in 2013, but neither turned into the global pandemic expected to strike one of these years.

One of the viruses, known as MERS, causes Middle East respiratory syndrome. The other, H7N9, is a new bird flu virus from China. Each virus has infected fewer than 200 people, but both kill a sizable number of the people who contract them. Although the viruses have not spread far from where they started, the scientific effort to decipher and combat them has had global reach.

The MERS virus was first isolated from a patient in Saudi Arabia by an Egyptian physician who sent the sample to the Netherlands to be tested. There researchers in the lab of Ron Fouchier (who made headlines in 2012 for work on the bird flu virus H5N1) deciphered the MERS virus's genetic makeup. It turned out that MERS is a coronavirus related to SARS, a virus identified in 2003 as the cause of severe acute respiratory syndrome (*SN: 3/23/13, p. 5*).

Since it first appeared in people in 2012, MERS has sickened 163 people, killing 71. Most of the victims live in Saudi Arabia, Qatar or the United Arab Emirates, or had recently traveled to the Arabian peninsula.

H7N9, a new strain of avian influenza, began circulating in China in February. The outbreak peaked by early April, nearly halting after Chinese officials closed live poultry markets. Still, sporadic cases appeared in the summer and fall, raising concerns that the virus could make a resurgence in the coming flu season (*SN Online: 10/15/13*). By early December, of the 139 people with confirmed H7N9 infections, 45 had died.

It came as a surprise that this type of bird virus was seriously sickening and killing people. Experts have been worried for a long time that the H5N1 bird flu would sweep the globe as the 1918 Spanish flu did. If H5N1 gained the ability to spread from person to person through the air while retaining its potency, it could potentially kill millions. But until this year, no serious human infections with H7N9 had ever been recorded.

As more and more cases of MERS and H7N9 infection appeared, scientists and health workers scrambled to investigate basic questions about the viruses: Where did they come from? How did they get into humans? How do they infect cells? And perhaps most important, do they spread easily from person to person, becoming a candidate for a pandemic? Only partial answers have emerged, and some are not comforting.

Researchers found molecular handles on human cells that the MERS virus grasps during infection (*SN Online: 3/13/13*). One study revealed that H7N9 can grow well in human lung cells (*SN Online: 7/3/13*).

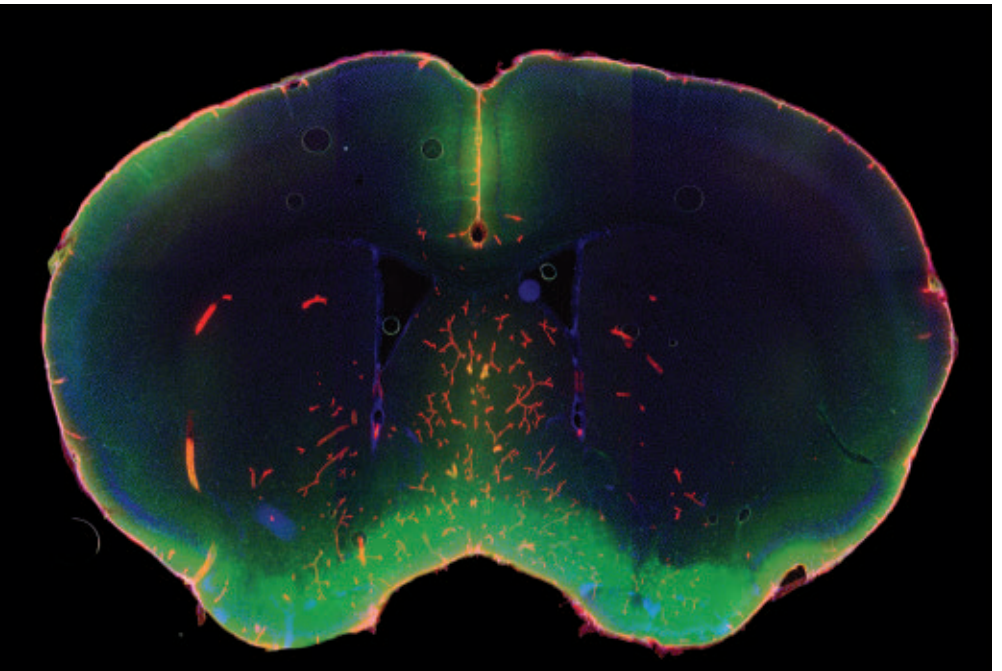
Studies of ferrets revealed that H7N9 can spread through the air from one of the animals to another, raising the possibility that it might also pass from person to person that way (*SN Online: 5/23/13*). But so far, the virus hasn't been easily transmitted between people. A few people may have spread the virus to their relatives, but most people probably caught it from chickens, ducks, pigeons or other birds at live poultry markets (*SN Online: 4/12/13, 4/15/13*).

71
MERS deaths since September 2012

45
H7N9 deaths in 2013

But the MERS virus does spread from person to person, particularly among people who are elderly or have other health problems. Hospital dialysis wards proved important for at least one big outbreak (*SN Online: 6/19/13*).

Researchers have been using DNA data and old-fashioned health sleuthing to track down the source of the MERS virus. It probably originated in bats and may have spread to camels and other animals before infecting humans (*SN: 9/21/13, p. 18; SN Online: 8/8/13, 10/9/13*). Whatever its origin, MERS probably made the leap from animals to people multiple times (*SN: 10/19/13, p. 16*). New cases of the virus continue to emerge, and there is ongoing concern that it could become a worldwide problem. ■



Tracer dyes (green, red) show where cerebrospinal fluid floods into the brain when a mouse is asleep. The fluid helps cleanse the brain of waste products that can build up and damage brain cells. Fluid flow nearly stops when the mice are awake.

6 Sleep clears the cluttered brain

Gunk between cells is cleansed during slumber

By Tina Hesman Saey

Sleep showers away cellular grime that builds up while the brain is awake — just the sort of process that could have made sleep a biological imperative, scientists reported in October (*SN: 11/16/13, p. 7*).

People have long puzzled over the evolutionary pressures that led animals to need sleep even though it leaves them vulnerable to predators and other dangers. Rinsing off the brain and disposing of waste proteins and other gunk might help explain why sleep evolved.

Many other things that sleep does, such as strengthening memories, are important. But they are probably bonuses to the real reason that slumber is necessary, says Suzana Herculano-Houzel of the Federal University of Rio de Janeiro.

Researchers led by Maiken Nedergaard of the University of Rochester Medical Center in New York stumbled upon sleep's cleansing function while studying how the brain disposes of waste products.

The brain pushes fluid in between its cells to flush out buildup products, such as protein pieces that form plaques in people with Alzheimer's disease, the team had found. After training mice to sit quietly on a microscope stage, the researchers could measure the fluid flow while the rodents were awake and asleep. Space between cells increased by at least 60 percent when the animals fell asleep, allowing cerebrospinal fluid to gush in and hose away buildup. When the animals woke up, some brain cells — probably ones called astrocytes — swelled up, narrowing the crevices separating the cells.

With the drainage system clogged, waste from hardworking nerve cells begins to pile up. Sleep deprivation or damage to the irrigation system may make it impossible for sleep to fully wash away the by-products, eventually contributing to neurodegenerative disorders such as Alzheimer's and Parkinson's diseases, the researchers speculate. ■

7 High court rules against gene patents

Justices open way for choices in DNA testing

By Tina Hesman Saey

A Supreme Court decision in June to strike down a company's patent on genes linked to breast cancer could have far-reaching consequences for biotechnology and medical research.

In a rare unanimous decision, the justices ruled that naturally occurring genes may not be patented. That ruling came in a case in which many scientists, activist groups and others sued Myriad Genetics. That company had previously patented the *BRCA1* and *BRCA2* genes. When mutated, those genes can greatly increase the risk of breast cancer.

Myriad's patent gave that company the exclusive right to conduct tests based on those two genes. The court's decision means that Myriad's patent is invalid and other companies may now offer *BRCA* tests. Several companies, including medical testing giant Quest Diagnostics, have already started offering such tests.

Patient advocacy groups, doctors and academic scientists embraced the decision, predicting that it would pave the way for cheaper, more readily accessible tests for inherited cancer risk.

Some people, though, warned that biotechnology companies would stop doing genetic research if gene patents aren't allowed. But the Supreme Court included a carrot along with the stick. Part of the decision included a provision that allows for patents of versions of genes known as cDNAs. Scientists cried foul at the justices' incorrect assertion that cDNAs don't occur naturally, but that provision could allow companies to patent certain aspects of their research (*SN Online: 6/14/13*). ■

L. XIE, H. KANG AND M. NEDERGAARD

8 Language learning starts before birth

Babies seem familiar with vowels, words heard while in womb

By Laura Sanders

Parents are usually careful to watch their language around young children. Maybe parents-to-be ought to watch what they say, too. Not only do babies slurp up language skills in the first few years of life, but new research also suggests that this precocious language learning starts in the womb.

In the later months of pregnancy, fetuses can detect and remember songs, native vowel sounds and entire words. These surprisingly sophisticated linguistic feats offer a new perspective on early learning. The results also raise the possibility of taking steps during pregnancy to help babies at risk for language problems.

Toward the end of pregnancy, sounds from the outside world can seep into a developing fetus's brain. Young babies show a clear preference for the sounds of their mothers' voices, familiar nursery rhymes and soothing lullabies, for instance. Four months after birth, babies who had heard "Twinkle, Twinkle Little Star" while in the womb remembered and recognized the lullaby, cognitive neuroscientist Eino Partanen of the University of Helsinki and colleagues reported October 30 in *PLOS ONE*. The music doesn't need to be baby-friendly, either. An earlier study found that babies born to mothers who had been hooked on a soap opera during pregnancy stopped fussing when the theme song started.

The findings extend the boundaries of what and when fetuses can learn. "We just don't know the limits," says psychologist Christine Moon of Pacific Lutheran University in Tacoma, Wash., who coauthored one of the new studies.

Moon and her colleagues found that fetuses learn to discern native vowel sounds from foreign ones. To catch babies before they had time to familiarize themselves with the outside world, the scientists studied Swedish and U.S. babies seven to 75 hours after birth. These newborns were hooked up to special pacifiers that detected sucking rates. The more sucking, the more unusual a sound was, the researchers reasoned.

> In the later months of pregnancy, fetuses can detect and remember songs, native vowel sounds and entire words.

Babies sucked more for foreign vowel sounds, Moon and her team reported in *Acta Pædiatrica* (*SN: 2/9/13, p. 9*), showing that the babies had grown familiar with native vowels while in the womb.

Fetal learning doesn't stop at vowels. Fetuses grew familiar with an entire made-up word, Partanen and colleagues reported in the *Proceedings of the National Academy of Sciences* (*SN: 10/5/13, p. 15*). In the last trimester, pregnant women blasted a recording of a researcher saying a fake word. Testing the babies' brain responses with electrodes soon after birth, a neural signature of familiarity called the mismatch response showed up in those who had heard the word during gestation. These babies' brains showed a big neural response when a syllable in the fake word was pronounced differently, suggesting that the normal version was familiar.

Such knowledge about fetal learning could one day lead to specially designed audio tracks that could boost language skills in fetuses at risk for language impairments such as dyslexia. Carefully crafted auditory cues played during pregnancy might stimulate the growing brain in a way that aids language skills.

The new work also draws attention to the importance of the acoustical environment for a fetus. Because the fetal brain is sensitive to sounds, constant exposure to a noisy environment might be problematic. Loud, unstructured noise could mask this early language acquisition and interfere with normal brain development. ■

Top exoplanet discoveries of 2013

With the addition this year of 180 new worlds to the Paris Observatory's list of confirmed exoplanets, there are now more than 1,000 known planets orbiting stars other than the sun. Here are some of the year's most notable finds:

1. The Earthiest
Kepler-78b is most similar to Earth in mass, diameter and composition; it could be made of rock with an iron core. But it's no Earth analog, whizzing around its star in 8.5 hours, with temperatures exceeding 2,000° Celsius.

2. The wettest
HR 8799c's atmosphere lacks methane, which could signal life, but does have water and carbon monoxide. Water has also been found in the atmospheres of WASP-17b, HD209458b, WASP-12b, WASP-19b and XO-1b.

3. The rogue
Planetary candidate PSO J318.5-22 has no parent star. The object is roughly six times the mass of Jupiter, has features similar to other directly imaged exoplanets, including HR 8799c, but floats through space all alone.

4. The runt
Kepler-37b is the littlest planet found to date. At 3,860 kilometers across, the exoplanet is about 30 percent of the diameter of Earth or 80 percent the width of Mercury.
—Ashley Yeager

9 Caffeine triggers cloning advance

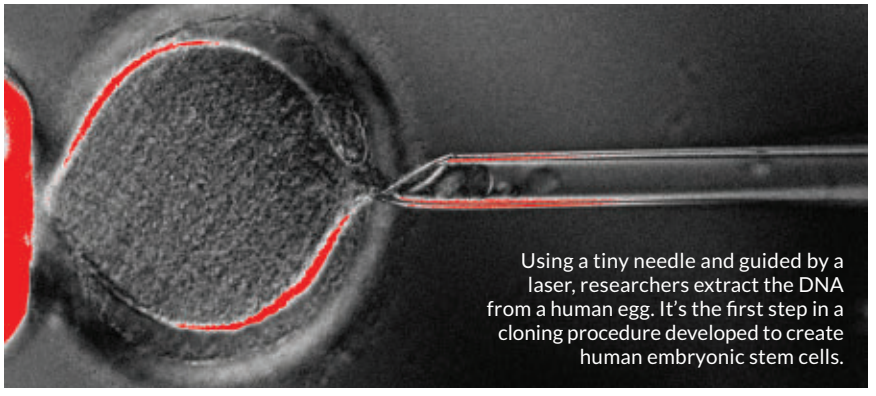
Human embryonic stem cells copied successfully

By Meghan Rosen

With a tweak to the technique that cloned a sheep in 1996, scientists have generated stem cells in the lab that genetically match those found in human embryos.

The feat pumps life into a sputtering field. Until now, researchers had to harvest the cells from embryos left over from in vitro fertilization, or tinker with ways to turn adult cells into embryonic ones, a task riddled with technical challenges.

Embryonic stem cells are so prized because they can transform into any type of cell in the body. This boundless potential carries the promise of personalized medicine: Doctors could one day dose patients with new, healthy cells made from patients' own bodies. Though scientists had previously cloned cells from frogs, sheep and even monkeys, no one had figured out how to perfect the procedure in human cells.



Using a tiny needle and guided by a laser, researchers extract the DNA from a human egg. It's the first step in a cloning procedure developed to create human embryonic stem cells.

The cloning procedure, called somatic cell nuclear transfer, requires scientists to remove the DNA-containing nucleus from an egg and replace it with one taken from an adult cell. Under the right conditions, the egg reprograms its new nucleus and develops into an embryonic stem cell. Because each animal's cells have their own quirks, scientists have to tailor the procedure for different creatures.

To successfully clone human cells, eggs must be dunked in caffeine, study leader Shoukhrat Mitalipov of the Oregon National Primate Research Center in Beaverton and colleagues found *(SN: 6/15/13, p. 5)*. This and other technical changes give researchers a new recipe for creating embryonic stem cells in the lab. And because the recipe doesn't rely on leftover embryos, it may sidestep some of the ethical issues surrounding stem cell research. ■

10 CO_2 levels pass milestone

Panel affirms humans' role in warming

By Erin Wayman

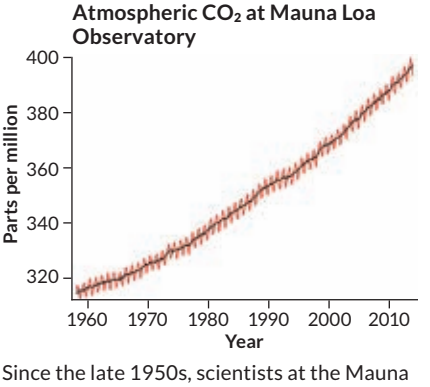
Even as skeptics continued to doubt human-caused climate change, scientists grew more confident than ever this year that people are driving global warming.

In September, the Intergovernmental Panel on Climate Change reported that it is 95 to 100 percent certain that human activity — largely fossil fuel burning — is the main cause of rising temperatures since the 1950s (*SN Online: 9/27/13*). The IPCC also dismissed a common argument that the apparent slowdown in global warming over the last 15 years is evidence that humans aren't altering climate.

The IPCC noted that small slices of time aren't good indicators of longer trends. And researchers at the Scripps Institution of Oceanography in La Jolla, Calif., determined that the recent global warming "hiatus" may be linked to natural fluctuations in sea surface temperatures in the tropical Pacific (*SN: 10/5/13, p. 14*).

Although scientists are confident about humankind's role in climate change, they still have a lot to learn about the magnitude and timing of future climate shifts. Some researchers are looking to the past for guidance. Many say the Pliocene epoch, 5.3 million to 2.6 million years ago, may be the best analog for Earth's future.

Back then, average global temperatures were a few degrees warmer, sea levels were higher and atmospheric carbon dioxide concentrations were about 400 parts per million — an amount the world will soon surpass. Last year, the Arctic hit the 400 ppm mark, and this year the atmosphere above the long-running Mauna Loa Observatory in Hawaii reached that milestone as well (*SN: 6/1/13, p. 20*). Scientists predict that the global average will rise to 400 ppm within a few years. ■



Since the late 1950s, scientists at the Mauna Loa Observatory in Hawaii have measured carbon dioxide levels in the atmosphere. While the precise level varies seasonally, the amount of CO_2 in the air has climbed steadily, reaching 400 parts per million this year.

FROM TOP: COURTESY OF M. TACHIBANA; NOAA

11 Putting kids at risk

Parents lax on vaccinations

By Nathan Seppa

AMANDA MILLS/CDC

The tenet that "doctor knows best" is taking a beating. U.S. parents increasingly are delaying their children's vaccinations, basing such decisions on sources other than their pediatricians, researchers reported in 2013. Nearly half of U.S. babies born from 2004 to 2008 fell behind on at least one vaccination (*SN: 2/23/13, p. 11*).

Many parents cite concerns about the 23 shots babies now get in the first two years of life, says epidemiologist Jason Glanz of Kaiser Permanente in Denver. "You can see the parents' perspective," he says.

Vaccination schedules have been fine-tuned to protect children at a vulnerable age, doctors point out, but they can't force the issue. Glanz and colleagues examined the records of 320,000 kids under age 2, finding that 49 percent got at least one shot more than a month late. That proportion has been rising for five years. Overall, 20 percent of kids spent more than 100 days unprotected against a disease because of late shots.

49 percent Kids who got at least one shot more than a month late

20 percent Kids who spent more than 100 days unprotected against a disease because of late shots

Vaccine fears arose over a decade ago when some people blamed shots for health problems, claims later shown to be unfounded. A 2013 study debunked more recent claims that vaccination can cause Guillain-Barré syndrome, a nerve-damaging disorder. A review of 3 million people in the Kaiser database showed no connection between the disorder and getting any vaccine (*SN: 7/27/13, p. 16*).

Putting off shots might be grounded in parents' desire to make safe choices for their child, say University of Pennsylvania physicians Kristen Feemster and Paul Offit, writing in *JAMA Pediatrics* in October. But in reality, "it offers no clear benefit," they say. Such parents may be well-meaning, but in this case doctors really may know best. ■

12 Voyager 1 reaches interstellar space

Planetary probe is first to pass beyond heliosphere

By Andrew Grant

When Caltech's Ed Stone watched the launches of Voyager 1 and Voyager 2 from Cape Canaveral in 1977, he had only a glimmer of hope that either probe would survive to reach interstellar space. "The space age was only 20 years old," says the missions' principal investigator. "We had no idea how long spacecraft could last."

Thirty-six years later, Stone announced that Voyager 1 had become the first human-made object to pass beyond the heliosphere, the giant invisible bubble inflated by subatomic particles from the sun, and enter the space between the stars *(SN Online: 9/12/13)*. Based on measurements from the probe's instruments, Voyager made its exit in August 2012.

But only in September of this year did Stone and his team, many of them original Voyager scientists, decide that they had enough evidence to confirm the crossing. The announcement carried a sense of déjà vu because multiple scientists had made the case in previous months that the milestone had been reached.

Now astronomers are digging into the probe's latest observations, the first from a region of space teeming with speedy protons and electrons expelled in the violent explosions of distant stars. Scientists have studied plenty of these particles with space-based detectors, but never in a pristine environment largely free of radiation and magnetic interference from the sun. "We're left with decades of interesting work ahead of us," says Gary Zank, a space physicist at the University of Alabama in Huntsville. ■

13 Death of a planet hunter

Kepler ends successful mission

By Andrew Grant

When NASA's Kepler space telescope launched in March 2009, astronomers had no proof that any star other than the sun harbored an Earth-sized planet (with a diameter within 25 percent of Earth's). By May 2013, when the telescope suffered a mechanical failure that ended its planet hunt, Kepler scientists had discovered 10 such worlds and identified hundreds of yet-to-be-confirmed Earth-sized candidates.

Kepler's death blow came when the second of four wheels used to orient the telescope failed. The spacecraft requires three wheels to home in on a patch of sky and search for planets that block out some of the light of their stars. Mission engineers tried to repair the wheels but gave up in August (*SN: 9/21/13, p. 18*).

While the telescope is probably done hunting planets, its data will keep astronomers busy for at least several years. William Borucki, Kepler's principal investigator, speculates that data not yet analyzed contain signals of the ultimate catch: Earth-sized worlds in the habitable zones of sunlike stars that could possibly support life. Already scientists have found intriguing worlds such as Kepler-62e and Kepler-62f, two planets slightly larger than Earth that could harbor liquid water on their surfaces (*SN: 5/18/13, p. 5*).

When Kepler was at full health, Borucki claimed that it was the greatest unmanned mission NASA has ever flown. That's up for debate — fans of the Hubble Space Telescope can make a strong case — but there's no question that Kepler has changed the way scientists view the galaxy. Statistical calculations based on Kepler data suggest that the Milky Way contains hundreds of billions of planets. And in April NASA approved the Transiting Exoplanet Survey Satellite mission, due for launch in 2017, to find the nearest ones to Earth. ■

14 Below absolute zero, but hot

Lab trickery achieves negative temperature

By Andrew Grant

Ulrich Schneider must be a hit at cocktail parties. The physicist at Ludwig Maximilians University of Munich can tell awed guests that he is responsible for creating both the world's hottest substance and lowest temperature — at the same time.

Schneider's substance — a gas consisting of about 100,000 potassium atoms — reached a temperature below absolute zero, about –0.000000001 kelvins.

Unlike Fahrenheit and Celsius temperatures, where the zero point is arbitrary, absolute temperature (measured in kelvins) supposedly can go no lower than zero. And in fact, nothing can get colder than absolute zero. But a negative absolute temperature, though technically below zero, is actually infinitely hot.

That's because a positive or negative sign on the kelvin scale describes the energy distribution of a substance's particles. Usually, most particles within a system have relatively low energies; only a few occupy the highest rungs of the energy range. In such situations temperature is always positive.

Schneider and colleagues reversed that distribution in their gas of potassium atoms. They used lasers and magnets to confine the atoms to a narrow band of energies. At first, most of the atoms possessed energies at the lower end of that band. But by altering the lasers and magnetic field, the researchers flipped the atoms' energy distribution. Suddenly most of the atoms were at the upper limit of the allowed energy. In that situation the gas had a negative temperature (*SN: 2/9/13, p. 10*).

At the same time, the gas was hotter than any substance with a positive temperature. Because of the glut of high-energy atoms, heat would flow from the gas to any substance with a positive temperature. And heat always flows from hotter to colder, by decree of the laws of thermodynamics.

Schneider's experiment offers scientists the rare opportunity to study a system that gets more orderly with increasing energy — adding energy causes more atoms to cluster at the high-energy limit. The researchers also noted that the potassium atoms, which should have collapsed toward each other, remained stable at negative temperatures. This repulsion might provide insight into dark energy, the mysterious component of the universe that counteracts gravitational attraction and causes the cosmos to expand at an accelerating rate. ■

[–0.000000001 kelvins]

Temperature reached by potassium atoms

NASA/KEPLER MISSION; STARRY BACKGROUND: IMAGEMAN/SHUTTERSTOCK

15 *DSM-5*'s controversial debut

Diagnostic manual updates disorder criteria

By Bruce Bower

When the American Psychiatric Association released the fifth edition of its *Diagnostic and Statistical Manual of Mental Disorder*s in May, big changes had already begun in the controversial business of defining mental disorders.

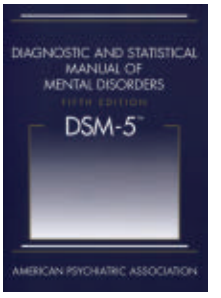
Psychiatrists involved in *DSM-5* had hoped to link mental ailments, from schizophrenia to depression, to specific biological markers. But scientists failed to find such markers. So the psychiatric manual set out roughly 300 disorders that were ratified, as in previous editions, by consensus in groups of clinicians and researchers (*SN: 6/29/13, p. 5*).

Some *DSM-5* adjustments provoked controversy. In particular, a tightened definition of autism and related conditions raised fears that some children would mistakenly go undiagnosed and be denied special school services. An allowance for classifying severe mourning as major depression was criticized for turning normal grief into an illness.

Still, *DSM-5*'s revisions were restrained compared with some planned for the World Health Organization's upcoming 11th edition of the *International Classification of Diseases*. WHO's diagnostic manual will simplify the current definition of post-traumatic stress disorder and add a severe form of the condition triggered by long-lasting or frequent distressing experiences. Those changes are aimed at improving the ability of mental health workers — especially the growing number of nonprofessional psychotherapists outside the United States — to treat victims of conflict and natural disasters.

Meanwhile, the U.S. National Institute of Mental Health has launched a 10-year effort to redefine mental disorders based on behavioral and brain findings. Dubbed the Research Domain Criteria, or RDoC, this federal program reflects researchers' exasperation with imprecise *DSM-5* diagnoses. RDoC intends to illuminate different underlying problems presumably afflicting people with the same *DSM-5* ailments.

Psychiatrists had similar aspirations for *DSM-5*. If they're lucky, *DSM-6* won't need to mention anything about Diagnostic Overreach Disorder. ■



DSM-5 eliminates subtypes such as paranoid and catatonic from the schizophrenia definition, replaces gender identity disorder with gender dysphoria, and adds several new disorders, including premenstrual dysphoric disorder, hoarding disorder, gambling disorder and excoriation disorder, in which people compulsively pick at themselves.

16 Obama unveils brain initiative

Project to seek secrets of thinking, learning

By Laura Sanders

A proposal to accelerate brain research may someday mark 2013 as the dawn of a golden era in neuroscience. In April, President Obama announced an ambitious plan to reveal the human brain's secrets (*SN: 5/4/13, p. 22*).

"There is this enormous mystery waiting to be unlocked," Obama said in a speech, "and the BRAIN Initiative will change that by giving scientists the tools they need to get a dynamic picture of the brain in action and better understand how we think and how we learn and how we remember."

The effort will be funded by the U.S. National Institutes of Health, the Defense Advanced Research Projects Agency and the National Science Foundation, along with a host of private foundations and companies.

Scientists and policy experts are still skirmishing over the focus and scope of the BRAIN Initiative, but some details are emerging. After a series of meetings with scientists around the country, a panel of neuroscientists settled on nine preliminary research priorities, ranging in scope from individual nerve cells to the entire brain (*SN Online: 9/18/13*).

The BRAIN Initiative will also fund scientists who develop new techniques to illuminate the coordinated behavior of large groups of nerve cells. Projects focusing on these initial nine priorities, which were approved by the NIH on September 16, are anticipated to receive $40 million of NIH funding in fiscal year 2014.

And the United States–based BRAIN initiative is not alone. On January 28, the European Commission awarded 1 billion euros to the Human Brain Project, an effort by 130 research institutes to develop the most precise model of the human brain yet. ■

17 Methane shortage on Mars

Trace of gas not enough to be sign of life

By Erin Wayman

After months of searching, the NASA rover Curiosity detected no appreciable methane in Mars' atmosphere, disappointing scientists who had hoped to find a strong sign of life on the Red Planet.

On Earth, microbes have churned out as much as 95 percent of all atmospheric methane, so finding that gas in Mars' air would have been solid circumstantial evidence of life. Instead, the rover measured no more than a trace of methane, with an average concentration of a mere 0.18 parts per billion (*SN: 10/19/13, p. 7*).

Many planetary scientists had expected that Curiosity would catch a whiff of methane. Over the last decade, researchers have measured fluctuating methane levels on Mars using Earth-based instruments and spacecraft. Some scientists have proposed that microbes buried beneath the planet's frozen ground produced the gas, which could have been unleashed during a seasonal thaw and then somehow quickly removed from the atmosphere. With more time, Curiosity might still discover such a methane release, says Michael Mumma of NASA's Goddard Spaceflight Center in Greenbelt, Md., who is not a member of the Curiosity team.

But even if such a discovery never happens, that wouldn't necessarily mean that Mars is barren. Microorganisms that don't generate methane might dwell on Mars, and the planet might have hosted now-extinct life at some time in the past. In March, NASA announced that Curiosity had uncovered evidence of an ancient, hospitable aquatic environment, home to energy-rich minerals that could have fueled life-forms (*SN Online: 3/12/13*). Those hospitable conditions lasted millions of years and ended as recently as 3.5 billion years ago, researchers reported in December (*SN Online: 12/9/13*).

Although the findings are enticing, the rover has yet to find organic compounds, the building blocks of life. ■

The concentration of methane in the Martian atmosphere measured by the rover Curiosity is one ten-thousandth that on Earth. High levels of methane on Mars would have been a compelling indication of life there.

JPL-CALTECH/NASA AND MSSS

18

Canine genealogy

Competing clues confuse story of dog domestication

By Meghan Rosen

The ancient lineage of man's best friend is kind of a tangled mess. But scientists made some progress this year in identifying dogs' ancestors and in estimating the timeline of canine domestication.

Dogs may have descended from a now-extinct wolf species, Adam Freedman of Harvard and colleagues reported in June (*SN: 7/13/13, p. 14*). They date dog domestication to between 11,000 and 16,000 years ago, before the rise of agriculture.

But not all the new clues tell the same story. Archaeologists have unearthed fossils from doglike animals in both Europe and Siberia that date to more than 30,000 years ago. And in November, Olaf Thalmann of the University of Turku in Finland and colleagues used DNA from the fossils to trace domestic dogs' origins to Europe between 18,000 and 32,000 years ago (*SN: 12/14/13, p. 6*).

In January, though, a team analyzing canine genes proposed that dogs became domesticated about 10,000 years ago. Other geneticists examining dog and wolf DNA have placed dogs' origin in both the Middle East and East Asia.

Freedman's work relies on genetic evidence from an Australian dingo, a Basenji, a golden jackal and wolves from Croatia, Israel and China — regions where experts have proposed that domestication occurred. The new data all but rule out modern-day wolves as dogs' ancestors. Still, the location and timing of dogs' domestication remain uncertain.

Because Freedman's and Thalmann's studies tap into a bigger pool of genetic data than previous work, though, their findings may offer better tools for scientists trying to untangle dogs' lineage. ■

Genetic analyses of various populations of living wolves from around the world suggest that modern dogs descend from a species of wolf that is now extinct.

DOBAK/FLICKR

19

Dark energy gets more confusing

New data raise prospect of 'Big Rip' destroying cosmos

By Gabriel Popkin

New measurements of light from distant exploding stars were supposed to illuminate the dark energy that is pushing the cosmos apart. Instead they have further shrouded the universe's fate.

Dark energy first made headlines in 1998, when researchers found that light from faraway supernovas was dimmer than expected, suggesting that the universe is expanding at a faster and faster pace. To explain this acceleration, scientists surmised the existence of dark energy, which pushes space outward (*SN: 4/7/01, p. 218*). Most physicists suspect that dark energy is a form of vacuum energy known as the "cosmological constant" because its strength never varies. If so, a number called w, which relates the pressure pushing space apart to the density of dark energy, must equal –1.

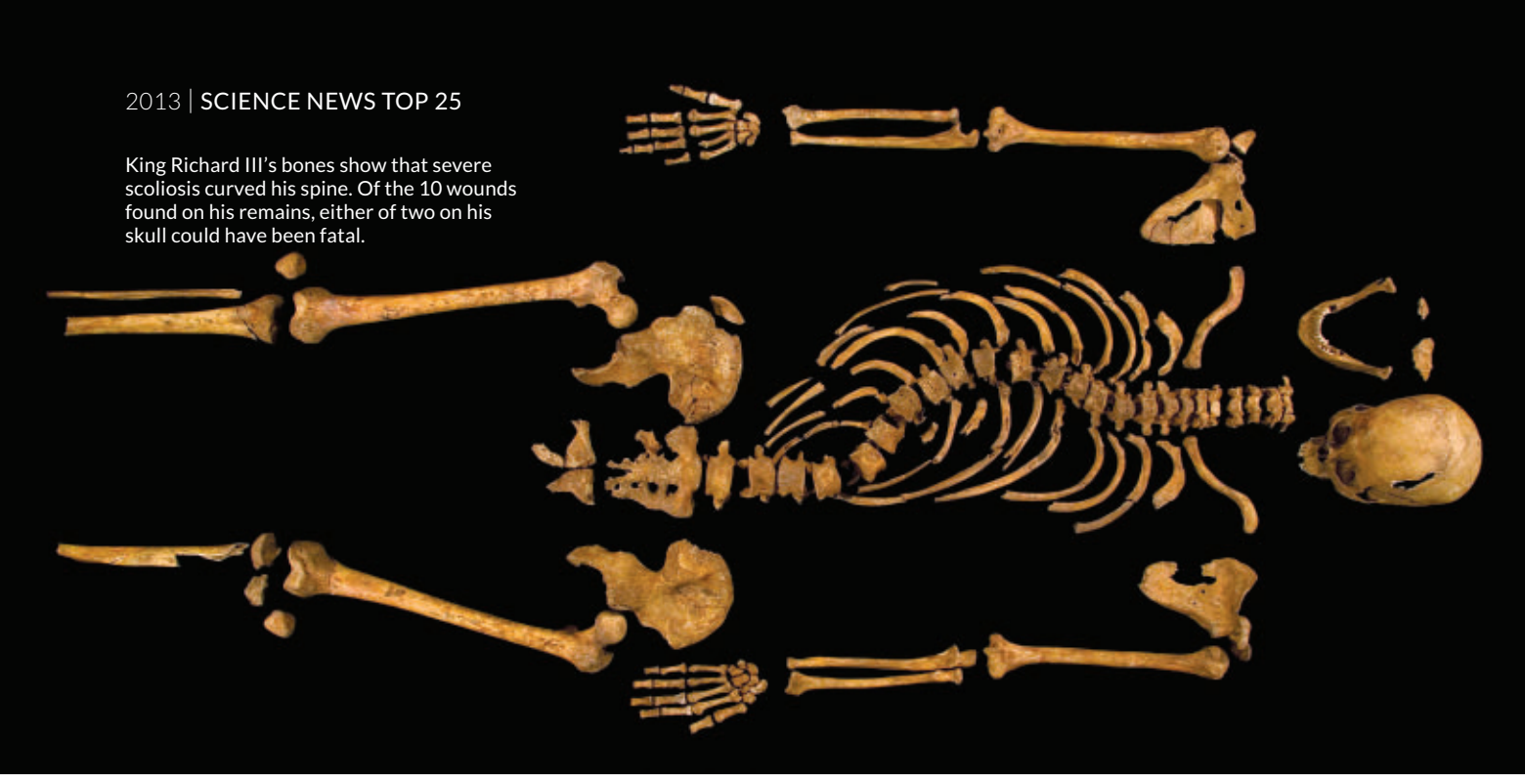
[–1.186]
Reported value of w

But this year, scientists using a powerful new telescope in Hawaii, part of project called Pan-STARRS, arrived at a different value for w. By combining the supernova data with previous results from other studies, the researchers calculated w to be –1.186.

This value, if confirmed, would force cosmologists to pursue more complicated theories in which dark energy's strength increases over time. If it does, the universe might ultimately be torn apart in what scientists call the Big Rip (*SN: 11/30/13, p. 8*).

So far, though, nobody is writing off the cosmological constant. The researchers say they and other groups must first look for sources of measurement error, starting with the telescopes they use to study far-off parts of the universe. Even slight discrepancies in how telescopes gather starlight that has traveled billions of light-years can introduce sizable differences in the data the instruments collect.

In two years, when cosmologists have more precisely calibrated their instruments and analyzed more data, they may know whether the cosmological constant needs to be scrapped. For now, says study coleader Armin Rest of the Space Telescope Science Institute in Baltimore, "My hunch is that w is –1." ■



King Richard III's bones show that severe scoliosis curved his spine. Of the 10 wounds found on his remains, either of two on his skull could have been fatal.

20 Slain king's bones dug up

Richard III's skeleton reveals fatal wounds

By Rachel Ehrenberg

It was reported 528 years late, but the top news from 1485 seems to be that King Richard III may have been killed by a blade thrust upward into his skull or an axe-whack to the back of his head.

Researchers at the University of Leicester in England performed the autopsy on the slain king after an excavation in one of the city's parking lots unearthed parts of Grey Friars Church, where he was buried. A genetic analysis confirmed the skeleton's identity; a descendant on the king's mother's side possesses mitochondrial DNA matching the victim's (*SN: 3/9/13, p. 14*).

Forensic details revealed by the skeleton generally conformed to the historical record. The well-preserved skeleton showed Richard to be a slight man with scoliosis — his spine curved like a question mark — though he wasn't quite "the foul bunch-back'd toad" that Shakespeare described. Richard's scoliosis would have reduced his height and caused one shoulder to stand higher than the other.

Richard's violent death occurred at the Battle of Bosworth on August 22, 1485. A few days later he was dumped into a hastily dug grave at the church in Leicester. The position of the skeleton's hands indicates they were tied at burial. The researchers discovered 10 wounds, several apparently inflicted after death.

Two of the wounds had the potential to be fatal. One gaping wound in the back of his head may have been from an axelike bladed pole known as a halberd. The other was caused by a blade that penetrated the skull at the base. ■

21 Progress made toward twin prime proof

Surprising advance sparks flurry of work on mathematical conjecture

By Dana Mackenzie

Some pan for gold, some pan for prime numbers. Yitang "Tom" Zhang may have found both.

Zhang, a mathematician at the University of New Hampshire, stunned the mathematical world in May when he reported a major step toward solving one of the oldest outstanding problems in number theory, called the twin prime conjecture (*SN: 10/19/13, p. 38*).

For more than 100 years, mathematicians have known that prime numbers — such as 7 or 17, with no divisors except for themselves and 1 — get sparser and sparser as the numbers get larger. They are like flecks of gold in a stream that is gradually running out of gold.

Nevertheless, mathematicians believe you can always find two prime "gold nuggets" in the same pan no matter how far downstream you go. If the separation between the primes is 2, they are called twin primes. Examples are 17 and 19, or 1,607 and 1,609. The twin prime

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22 Visitor from the Oort cloud

Comet ISON meets demise in solar flyby

By Gabriel Popkin

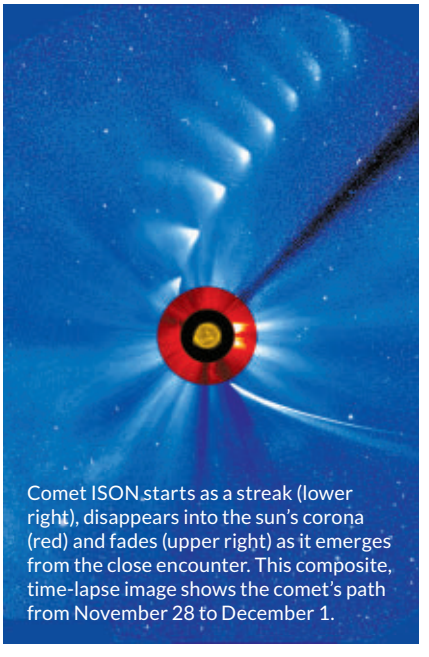
Comet ISON was an ordinary-sized comet with an extraordinary story. It started out millions of years ago in the faraway Oort cloud (*SN: 10/19/13, p. 19*), where remnants of the early solar system hang out in deep freeze. A passing star may have given one of these remnants a nudge, launching it on a journey that would bring it to within 1.2 million kilometers of the sun in 2013.

Two astronomers with the International Science Optical Network discovered the remnant in September 2012, while it was still outside Jupiter's orbit. Scientists quickly realized that ISON would be the first known Oort cloud object to pass near the sun. The sun's light and heat would vaporize this fossil of the primordial solar system layer by layer, in full view of the world's most powerful telescopes.

From early observations, scientists learned that ISON was already throwing off lots of dust and ice. This finding further confirmed that ISON was on its first trip to the inner solar system; a regular visitor like Halley's comet would have lost its surface ice long ago (*SN: 11/16/13, p. 14*).

But the real spectacle came around Thanksgiving. As ISON rounded the sun, solar observatories got a close look at the comet. By December 3, most astronomers agreed that ISON had lost its nucleus, and all that remained of the comet was dust.

Though initial forecasts that ISON would outshine the full moon went unfulfilled, the combination of the comet's unique trajectory, its early discovery and today's sophisticated telescopes made ISON one of history's most studied comets. ■



Comet ISON starts as a streak (lower right), disappears into the sun's corona (red) and fades (upper right) as it emerges from the close encounter. This composite, time-lapse image shows the comet's path from November 28 to December 1.

ESA & NASA/SOHO/SDO

conjecture says such pairs never run out. It's called a "conjecture" because no one has been able to prove it.

Zhang proved that you can catch as many pairs of primes as you want if you use a pan whose width is at least 70 million. (Of course, they may or may not be twin primes.) Zhang did so in spite of being a relative unkown in the field of number theory. "No one had a clue that he was working on the problem," says Andrew Granville of the University of Montreal. Nevertheless, Granville says, Zhang's paper, to be published in *Annals of Mathematics*, is "beautifully written, just stunning, masterful work."

Mathematicians have been frantically competing since May to improve on Zhang's result. So far the narrowest pan known to work is 4,680 numbers wide. But James Maynard of the University of Montreal announced in November that he can bring the number down to 600. Further advances are almost certainly in the offing, but it is considered unlikely that the size will soon be brought down to 2, which would prove the twin prime conjecture. ■

The year in genomes

Scientists continue to decode the genetic blueprints of the planet's myriad flora and fauna — both alive and long dead — shedding light on biology, evolution and disease. Highlights from 2013 include:

1. Comb jellies A genomic analysis of comb jellies confirmed that the squishy marine predators are the new oldest animals, bumping the much simpler sea sponges from the base of the animal evolutionary tree (*SN: 5/18/13, p. 20*).

2. Ancient horse The oldest genome yet sequenced came from a horse's foot bone dating to between 780,000 and 560,000 years ago that was excavated in Canada's Yukon. The feat revealed that horse ancestors originated 2 million years earlier than previously thought (*SN: 7/27/13, p. 5*).

3. Big cats Genome sequencing of a Siberian tiger, Bengal tiger, African lion, white African lion and snow leopard identified genes behind the carnivores' ferocious metabolism and powerful pouncing skills (*SN: 10/19/13, p. 6*).

4. Duck The mallard duck genome gave researchers clues about how flu viruses that can infect humans develop in waterfowl.

5. Spruce With nearly seven times the DNA of the human genome, the Norway spruce tree has the largest genome yet decoded (*SN Online: 5/22/13*).

6. Coelacanth The prehistoric-looking, lobe-finned fish's genome revealed that it is not the closest living relative to land-traversing tetrapods — lungfish take that title (*SN: 5/18/13, p. 18*).

—Beth Mole

Cicadas such as this one in Virginia, from the Brood II group of the *Magicicada* genus, began to emerge in May after living underground for 17 years.

23 Odd cicada history emerges

Brood II returns better understood

By Susan Milius

For a few weeks in 2013, a chorus of headlines about the raucous reproduction of periodical cicadas just about drowned out the real cicada news.

This was the year for a cohort of big, reckless, ruby-eyed bugs to break out of the soil for their first and only chance to mate after 17 years of sucking plant roots in the dark. Synchronized generations of three *Magicicada* species designated as Brood II reliably emerge every 17 years in a swath of the U.S. East Coast from the southern Appalachians to New York (*SN: 7/13/13, p. 26*).

In just about any year, one of the 15 numbered *Magicicada* broods emerges somewhere. But Brood II is big and pops out in cities with major news outlets. The 2013 breakout would have been really big science news only if it hadn't happened.

Still, a synchronized emergence of *Magicicada* species is one of the great spectacles of nature. These are not the annual or dog-day cicada species, which appear each year in late summer. Out of several thousand cicada species on the planet, only the seven kinds of *Magicicada*, which live just in the eastern and central United States, make their loud, synchronized appearances at 13- or 17-year intervals. Broods don't overlap much in any particular grove of trees. So a chance to experience the surging chorus of a particular backyard's periodical cicadas comes only a few times in a human life.

What actual scientific cicada news there was in 2013 didn't get much media attention. Chris Simon of the University of Connecticut in Storrs and colleagues pooled DNA data collected during 30 years to create a bizarre but beautiful genealogical tree of *Magicicada*'s evolutionary history.

It's a long, strange story, almost musical in the way patterns echo each other in independent branches. One example: Roughly 4 million years ago, *Magicicada* ancestors started splitting into three distinctive forms (Decim, Cassini and Decula), the researchers reported in April. Then each of these groups split into both 17-year and 13-year forms.

Brood II, like most other broods, mixes splinter populations of all three original groups, even though they don't breed with each other. It's evolutionary weirdness that the well-trained ear can hear. Cassini-type males rev like electric carving knives. Deculas cough out rasps. Decims whistle-drone like B-movie spaceships. Anyone who missed the distinction this time can hear it all again in 2030. ■

FROM TOP: TOM SIEGFRIED; COURTESY OF *SCIENCE*/AAAS

24 Gift of steroids keeps on giving

Mouse muscles stay juiced long after doping ends

By Tina Hesman Saey

Once a cheater, always a cheater, a mouse study found — at least when it comes to steroids. The result, reported in October, strongly implies that anabolic steroids like testosterone give doping athletes a competitive advantage for years — perhaps even decades — after they stop taking the drugs. If antidoping agencies were to revise steroid bans based on the results, those caught cheating might effectively face lifetime

25 Meteorite makes an impact

Space rock fires a warning shot

By Andrew Grant

This meteorite, weighing more than 570 kilograms, was recovered from a Russian lake in October.

expulsion from competition.

In the experiment, female mice dosed with testosterone bulked up their muscles considerably. Along with increasing the size of muscle fibers, the steroid-treated animals boosted the number of nuclei in their muscle cells by up to 66 percent, Kristian Gundersen of the University of Oslo and colleagues reported October 28 in the *Journal of Physiology* (*SN: 11/30/13, p. 7*). Nuclei, which skeletal muscle cells naturally possess multiple copies of, store the bulk of a cell's genetic information. More nuclei make it possible to build more of the proteins that give muscle fibers their strength.

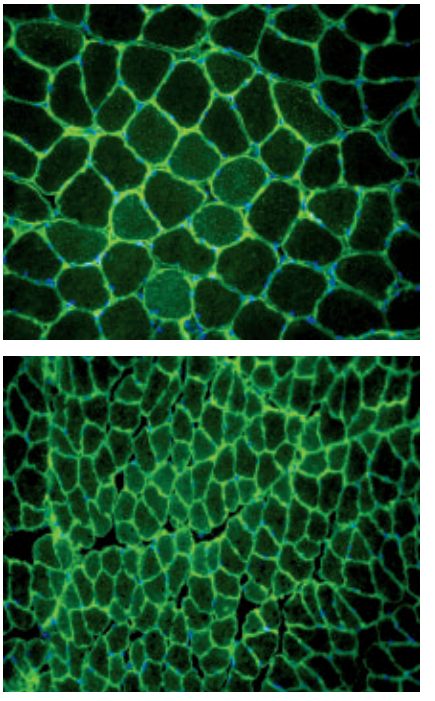
When the drugs were stopped, steroid-pumped mouse muscles shrank back to normal size. But they didn't lose the extra nuclei, Gundersen's team found. Three months later (which translates to about a decade of human life span) the muscle fibers were still hanging on to their ill-gotten nuclei.

6 percent
Muscle mass added after six days of exercise in mice that never got steroids

31 percent
Muscle mass added after six days of exercise in former mouse dopers

And the former dopers' muscles bulked up 31 percent with six days of exercise. The same regimen added about 6 percent of muscle mass in mice that never got steroids.

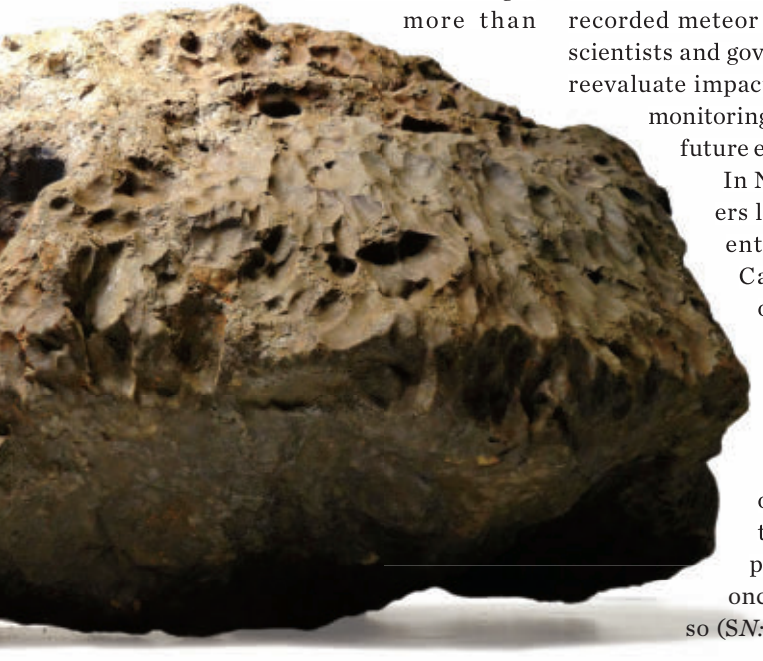
There is currently no way to safely and ethically conduct a comparable study in people. But human and mouse muscles probably react similarly to steroids. "The implication," says Lawrence Schwartz, a cell biologist at the University of Massachusetts Amherst, "is once you have these nuclei, you never lose them." ■



Muscles in mice treated with steroids (top) grow bigger than muscles in undrugged mice (bottom). Steroids also increase the number of a muscle cell's nuclei, which may help rebuild mass long after the steroids are gone.

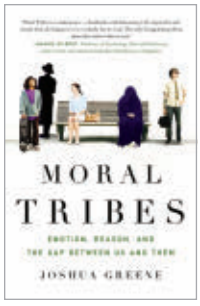
J.C. BRUUSGAARD/UNIV. OF OSLO

When a known asteroid passed within 28,000 kilometers of Earth on February 15, astronomers hoped it would serve as a wake-up call about the danger of meteorite impacts. As it turned out, astronomers got more than they had bargained for. On that same day, a 19-meter-wide space rock plowed through the atmosphere and exploded over southwestern Russia near Chelyabinsk, shattering windows and causing more than 1,600 injuries. The largest recorded meteor since 1908 spurred scientists and government officials to reevaluate impact risks and increase monitoring and preparation for future events.



In November, researchers led by planetary scientist Peter Brown of Canada's University of Western Ontario analyzed the last two decades of impact data and concluded that rocks the size of the one responsible for the Russian meteor probably strike Earth once every 30 years or so (*SN: 11/30/13, p. 6*). The previous estimate, based on ground-based telescope surveys that count up nearby space rocks of various sizes, was once every 120 years. Ground-based telescopes can spot giant, civilization-threatening asteroids in Earth's orbital neighborhood but identify only a tiny fraction of rocks tens of meters wide.

Scientists hope a series of new ventures will increase their understanding of impact threats. In August, NASA announced that it would revive a decommissioned space probe, the Wide-field Infrared Survey Explorer, to conduct a three-year survey of near-Earth objects. Meanwhile, the private B612 Foundation plans to launch a telescope by 2017 that would spot nearby asteroids as small as 30 meters across. And in October the United Nations approved an International Asteroid Warning Network to keep a census of potentially dangerous rocks and a Space Missions Planning Advisory group to consider ways to deflect an incoming asteroid. ■



BOOKSHELF

Moral Tribes

Emotion, Reason and the Gap Between Us and Them

Joshua Greene

Monks, mobsters and everyone else heed moral codes, even if these codes seem incomprehensible or repellent to outsiders. All moral thinking boils down to two basic conflicts, writes philosopher and neuroscientist Greene: "me versus us" and "us versus them."

His argument goes like this: In the small tribes that dominated human evolution, moral rules emerged as a way to encourage individuals to put the best interests of a home group — "us" — ahead of "me." Moral systems also prompted tribal people to value "us" over competing groups, or "them."

"Me versus us" morality works pretty well by relying on intuitions, such as a widespread impulse to punish comrades who don't contribute their fair share, Greene says. But in "us versus them" situations, moral instincts can trigger mayhem, from civil wars to bitter stand-offs over abortion. For groups in conflict, Greene recommends overriding intuitions and hashing out compromises to ensure the happiness of all.

Greene's argument stems largely from experiments in which volunteers solve hypothetical moral dilemmas, such as whether to push a man into a trolley's path to save five others. Chapters describing these studies are a tough slog, and the author even advises casual readers to skip a couple of them.

Much of the book, though, presents intriguing takes on moral affairs. It's questionable to what extent Greene's hypothetical trolley scenarios generalize to real-life moral dilemmas, in which people are less certain of possible actions and outcomes. And the author's defense of abortion — in short, that there's no evidence that a fetus becomes worthy of moral consideration in one magical moment, so how late in a pregancy to allow abortion is an arbitrary decision — is a guaranteed debate-starter, whatever your moral tribe. — *Bruce Bower*
Penguin Press, $29.95

BOOKSHELF

The Aesthetic Brain

How We Evolved to Desire Beauty and Enjoy Art

Anjan Chatterjee

Why is a rose beautiful? This doesn't seem like a question for science, yet an emerging field called neuroaesthetics seeks to understand art and beauty from a scientific perspective, by understanding the roots of beauty in the brain.

Chatterjee is a neuroscientist, so readers might expect a mechanistic treatise on beauty constructed from PET scans and clinical trials. But he offers no simple marriage of roses and neurons. To begin filling in the blanks left by neuroscience, he draws from anthropology, evolutionary biology, philosophy and personal anecdotes.

In the chapter "Beautiful landscapes," for instance, Chatterjee discusses the savanna hypothesis, a theory explaining the attraction of young children to savanna-like vistas over other landscapes in side-by-side picture tests. As we grow older, experiences with different environments may alter that preference, but the finding suggests a hardwired attraction to particular landscapes: the lands of our ancestors.

"The savanna hypothesis is romantic," Chatterjee writes. "It invites us to imagine that we humans are yearning for home, expressing a collective unconscious desire to return to our ancestral roots." Likewise, symmetries, averages and certain repeating patterns are rated as beautiful across cultures, implying that evolution has shaped human preferences for certain stimuli.

Chatterjee argues that pleasure-seeking lies at the root of the aesthetic experience. But in trying to explain the pleasure of beauty, the question naturally arises: To what end? What value is there in understanding art's ties to the brain, when art's livelihood depends on a dash of mystery?

As Chatterjee reminds us, insight is the goal of both science and art. His work succeeds by combining both toward a greater appreciation of the human experience. — *Bryan Bello*
Oxford Univ. Press, $34.95

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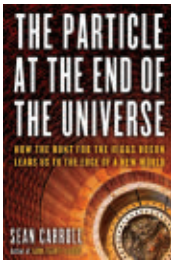
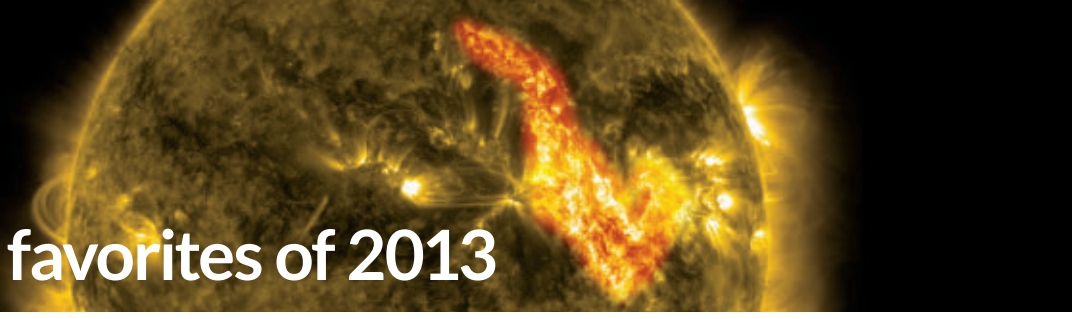
BOOK AWARD

Higgs boson tale wins book prize

The story of the decades-long hunt for the Higgs boson has won Britain's 2013 Royal Society Winton Prize, which includes a £25,000 award for the best science book written for a general audience. Sean Carroll's *The Particle at the End of the Universe* (*SN: 12/15/12, p. 30*) delves into the theory that suggested the particle's existence, then describes the exhilarating final moments of discovery and what the Higgs may mean for future generations of scientists.



Short-listed for the prize were *Bird Sense* by Tim Birkhead, *Cells to Civilizations* by Enrico Coen, *Pieces of Light* by Charles Fernyhough, *The Book of Barely Imagined Beings* by Caspar Henderson and *Ocean of Life* by Callum Roberts. Read the first chapter of each book at bit.ly/SNbookprize2013.
— *Erika Engelhaupt*

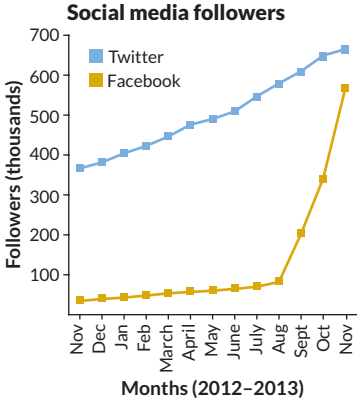


Reader favorites of 2013

For this issue, the editors selected the 25 most important and intriguing science stories of the year. But online readers seemed to point to a different bunch, showing just how subjective such an exercise can be. While it's difficult to gauge reader opinions based solely on letters, we can and do follow readers' mouse clicks online. Here are the most popular magazine stories of the year, according to website statistics.

Social climber

The number of people finding *Science News* articles through social media surged this year, including a spike in Facebook fans (below) that was a pleasant surprise. On Twitter, physics and astronomy stories were the biggest hits, with negative temperature and new-found exoplanets topping the most-clicked list. Similar topics got the most "like" votes on Facebook, as well as health stories such the life-extending benefits of eating nuts (see Page 11).



Top 10 most-read stories

1 **Life found deep below Antarctic ice**
Editor Janet Raloff, freshly back from Antarctica, scooped other science magazines with this story of living cells discovered in Lake Whillans, which sits 800 meters below the surface of an ice sheet (*SN: 3/9/13, p. 12*).

2 **Shorter-winged swallows evolve around highways**
Over 30 years, cliff swallows' wings got shorter on average, possibly making them more nimble, and the number of the birds killed along roads in Nebraska plunged (*SN: 4/20/13, p. 17*).

3 **Counting cracks in glass gives speed of projectile**
Physicists discover a simple relationship between the number of cracks in a plate of glass and the speed of the object that broke it (*SN: 6/1/13, p. 15*).

4 **The bright side of sadness**
A feature story on bad moods reveals their surprising upsides, such as an analytical thinking style, better memory for detail and greater fairness (*SN: 11/2/13, p. 18*).

5 **Ratio for a good life exposed as 'nonsense'**
A much-touted ratio of positive to negative emotions that supposedly enables life success was exposed as mathematical bunk (*SN: 9/7/13, p. 5*).

6 **Heavy drinkers get extra brain fuel from alcohol**
People consuming eight or more drinks per week get bonus energy from acetate, a breakdown product of alcohol (*SN: 4/20/13, p. 8*).

7 **Bioengineered kidney transplanted into rat** (#2 in Top 25)
A rat kidney stripped down and then rebuilt with new cells is functional and even produces small amounts of urine (*SN: 5/18/13, p. 14*).

8 **Tiny human almost-brains made in lab** (#2 in Top 25)
Human stem cells in a laboratory experiment form neural balls containing various brain structures and neuron types (*SN: 9/21/13, p. 5*).

9 **Hottest temperature ever measured is a negative one** (#14 in Top 25)
Potassium atoms chilled to just above absolute zero are flipped to a high-energy state using lasers and magnets, sending the particles into a negative kelvin range that is paradoxically hot (*SN: 2/9/13, p. 10*).

10 **Solar explosion forms 'Canyon of Fire'**
A September eruption (shown at top) leaves a huge scar where a filament of charged particles blasted away from the sun (*SN: 11/30/13, p. 32*).

SOLAR DYNAMICS OBSERVATORY/NASA

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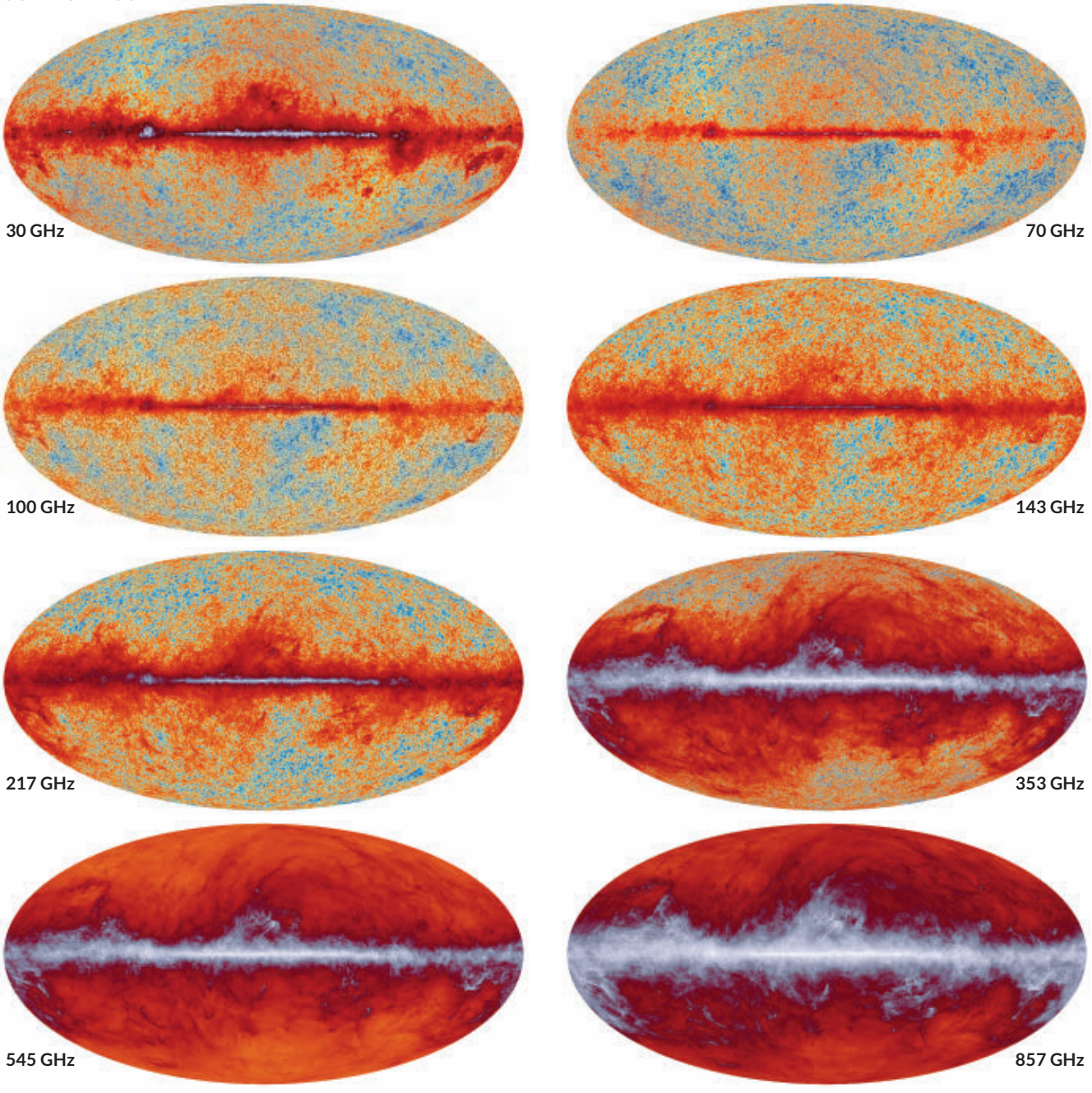

Top three rows: Deviation in microkelvin from average CMB temperature
Bottom row: Surface brightness in kilojanskys per steradian

Best maps of the universe, bugs and all

Maps from the European Space Agency's Planck satellite reveal the cosmos in a range of microwave and infrared frequencies. Planck's primary mission was to precisely measure the cosmic microwave background: 13.8-billion-year-old radiation that allows astronomers to probe the universe's first moments (see Page 21). The CMB appears as speckles; blue regions are slightly colder than the average CMB temperature of 2.7 kelvins, while orange ones are warmer. To study these tiny fluctuations, scientists must filter out galactic radiation emitted by speedy electrons (red at lower frequencies) and dust grains (red and white at higher frequencies). "From the standpoint of the CMB, all this foreground stuff is like bugs on a windshield," says Planck project scientist Charles Lawrence. "But entomology is an interesting subject." The maps will help astronomers learn more about the Milky Way, as well as the history of the cosmos. —*Andrew Grant*

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Chicago Doctor Invents

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This watch doesn't do dainty. And neither do I. Call me old-fashioned, but I want my boots to be leather, my tires to be deep-tread monsters, and my steak thick and rare. Inspiration for a man's watch should come from things like fast cars, firefighters and power tools. And if you want to talk beauty, then let's discuss a 428 cubic inch V8.

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No matter what, this watch can keep up. Thanks to the Stauer 30-day Money Back Guarantee, you've got time to prove it. If you're not totally satisfied, return it for a full refund of the purchase price. You also get a 2-year replacement guarantee on both movements. But I have a feeling the only problem you'll have is deciding whether to keep the Stauer ***Centurion*** on your dresser or tucked inside your toolbox.

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— C.S. from Fort Worth, TX

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