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ScienceNews

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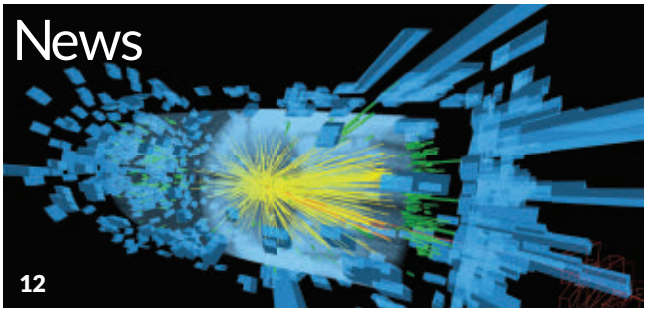
Features

News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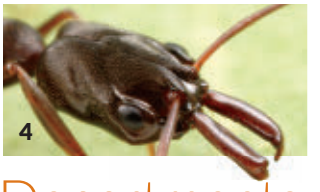
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Departments

COVER Earth will get its first good look at Pluto and its largest moon Charon when New Horizons sails past on July 14. *NASA, Johns Hopkins University Applied Physics Laboratory, Southwest Research Institute*

CLOCKWISE FROM TOP LEFT: PHOTO ILLUSTRATION BY E. OTWELL. BACKGROUND/BODIES: RUBBERBALL/SUPERSTOCK. MODEL FACES: SENSORSPOT/ISTOCKPHOTO; ALEX WILD; JAVIER TRUEBA/MADRID SCIENTIFIC FILMS; CMS/CERN

Pluto at last

On the New Horizons mission home page, the days, hours, minutes and seconds count down as you watch. The distance the spacecraft still has to travel to reach Pluto updates every minute, to within the nearest kilometer. Next month, the interplanetary journey, which has taken more than nine years and nearly 5 billion kilometers, will end in a relatively fleeting flyby. New Horizons is traveling so fast that there will be only a few days when its target is in close view.

But this carefully orchestrated space ballet will permanently change the face of Pluto. The dwarf planet will transform from a pixelated blur into a sharp image of rock and ice. Along with this photographic face-lift, Pluto will finally come into focus scientifically, as Christopher Crockett describes on Page 16. The mission to this remote outpost on the edge of the familiar part of our solar system will help answer questions about why Pluto's atmosphere is drifting off into space and whether it's home to ice volcanoes. It will also start to fill in the picture of what's beyond Pluto's orbit — the sea of icy objects that make up the Kuiper belt. This dim population of planetary leftovers circles the sun in a far region that's still largely unexplored.

The reenergized Large Hadron Collider, now smashing particles at higher energies than ever before, is also exploring new frontiers, as Andrew Grant reports on Page 12. Physicists hope this round of collisions will generate new cracks in their theories about the particles and forces at work in the universe, leading to new insights.

Scientists searching for an explanation of the apparent pause in global warming may now switch gears, thanks to insights from the National Oceanic and Atmospheric Administration. NOAA's new analyses suggest the observed hiatus was just the result of biased data; correcting for that reveals a clear increase in the rate of global warming this century, Thomas Sumner writes on Page 6.

Precision matters, whether we're looking at global temperatures, subatomic particles or the carefully timed approach to a faraway world. Be it a planet or not.

— Eva Emerson, Editor in Chief

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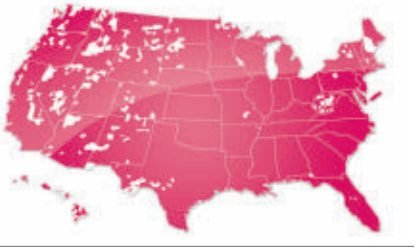

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Excerpt from the July 31, 1965, issue of *Science News Letter*

50 YEARS AGO

Invasion of classroom by gadgets foreseen

Machines that may teach the students of the future are attracting both industrialists and educators. One gadget enables each student in the classroom to take tests that are corrected as they are given, with the student "talking back" to the teacher. Typewriters operated by the student will admonish and inform the learner when a wrong answer to a problem is typed.

UPDATE: The 1970s saw the advent of the Scantron, changing the face of multiple-choice tests. The arrival of the handheld calculator in the 1970s and the graphing calculator in 1985 then altered math and physics classes. Mass-market computers appeared in the early 1980s and quickly overran classrooms. Now students around the world attend class via the Internet, and 3-D printers (*SN: 3/9/13, p. 20*) produce parts that students can use to invent and engineer. But despite technological change, some things remain the same. Students retain more when they take notes with pens than with laptops (*SN: 5/31/14, p. 14*).

Powerful jaws make the *Odontomachus brunneus* ant a skilled escape artist.

IT'S ALIVE

How a trap-jaw ant carries a baby

Surprisingly gently. That's how *Odontomachus* ants use their trap jaws to move soft, wriggly larvae around the nest. When ants hunt, though, those same jaws can smack shut at speeds exceeding 200 kilometers an hour.

"The poor prey are smashed. Sometimes they stick to the teeth; sometimes they bounce away," says Fredrick Larabee of the University of Illinois at Urbana-Champaign.

The difference between butcher and nursemaid is in the ant's preparation. Before a killing strike, jaw muscles clench hard. Their pull distorts parts of the head that will pop back into shape, powering the jaw to slam the instant a trigger muscle frees a latch. For slower, gentler tasks, the ants use jaw muscles with the latch unlocked.

The *O. brunneus* ant, at more than half a centimeter long, looms as a hulk among all trap-jaw species. Lock-and-spring-load jaws evolved at least four times independently in ants, but mostly among tiny species. Miniature ants use trap jaws to hunt equally tiny springtails, which use their own springs to fling themselves airborne and escape attack. The trap jaw versus springing tail represents "an evolutionary arms race in terms of speed," Larabee says.

Just what pushed the evolution of trap jaws in ants as big as *O. brunneus* remains a puzzle. They don't specialize in springtail nuggets, but trap jaws might help with other fast — or dangerous — prey. Larabee says that *Odontomachus* ants are known to kill termite soldiers that shoot a noxious defensive chemical out of their heads.

Power-amplified jaws could even improve the ants' chances of surviving some of their own predators, Larabee and Andrew Suarez report May 13 in *PLOS ONE*. They let *O. brunneus* trap-jaw ants skid down the sandy sides of traps dug by a predatory insect called an ant lion (*SN: 7/12/14, p. 4*). The ants doubled their survival rate if they were free to fire their jaws against the ground and recoiled skyward.

"In real life it happens so quick — you blink, you miss it," Larabee says. It's almost more fun to watch on YouTube. Almost. — *Susan Milius*

ALEX WILD

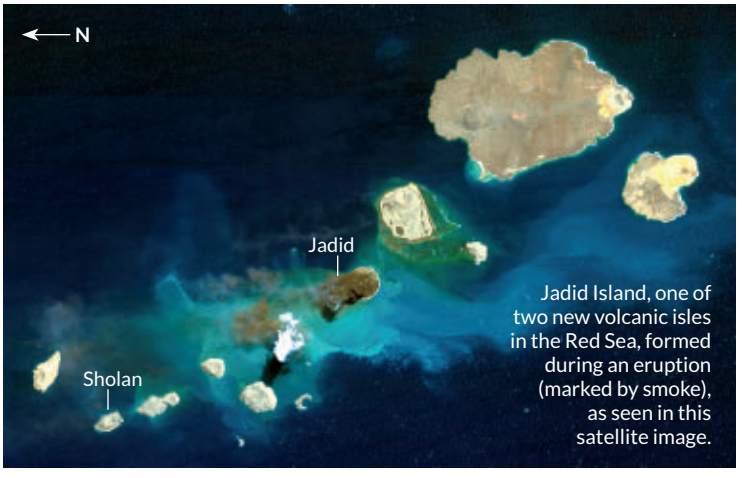
Watch a video of spring-loaded ants' escapes at **bit.ly/SN_trapjaw**

THE -EST

Oldest avian relatives of modern birds

Two partial skeletons unearthed in northeastern China have dashed the record for the oldest avian relatives of today's birds. The remains belonged to a species called *Archaeornithura meemannae* that lived 130.7 million years ago — about 6 million years earlier than the previous record holders. Fossil hunters discovered bones of the hummingbird-sized creatures embedded in siltstone slabs in what may once have been a lake. Stubby feathers stipple the ancient birds' bodies, except for on the lower legs. These bald patches hint that the animals (illustrated below) once waded through watery homes, suggest Chinese Academy of Sciences paleontologist Min Wang and colleagues May 5 in *Nature Communications*. — *Meghan Rosen*

A partial skeleton reveals a small feathered creature that may have had a semiaquatic life.



Jadid Island, one of two new volcanic isles in the Red Sea, formed during an eruption (marked by smoke), as seen in this satellite image.

CLOCKWISE FROM TOP LEFT: ZONGDA ZHANG; M. WANG *ET AL*/*NATURE COMMUNICATIONS*; JÓNSSON *ET AL*/*NATURE COMMUNICATIONS*

INTRODUCING

New volcanic islands

Update your maps: Two new islands have popped up in the strip of ocean between Africa and the Arabian Peninsula.

Witnessing the birth of a volcanic island is incredibly rare, but thanks to satellite images, researchers from the King Abdullah University of Science and Technology in Thuwal, Saudi Arabia, retraced the formation of two islands in the Red Sea.

The new islands, called Sholan and Jadid, formed where two tectonic plates pull apart at a rate of about 6 millimeters a year. Magma burst through cracks in Earth's crust during weeks-long eruptions, piling up rock and creating the new isles, one in 2011–2012 and the other in 2013. The larger island, Jadid, is about one-fifth the size of New York's Central Park, the researchers report online May 27 in *Nature Communications*.

Anyone wanting to take advantage of the new seaside real estate should act fast: By February 2014, erosion had already shrunk Sholan Island by about 30 percent. — *Thomas Sumner*

SCIENCE STATS

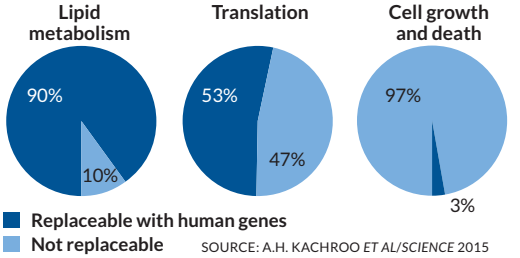
When evolution leaves genes alone

The last shared ancestor of humans and baker's yeast, *Saccharomyces cerevisiae*, lived 1 billion years ago. Despite the evolutionary gulf, human genes can substitute for nearly half — 47 percent — of the genes essential for yeast survival, researchers report in the May 22 *Science*.

Aashiq Kachroo and colleagues at the University of Texas at Austin replaced each of 414 genes in yeast with a human version. Genes with some functions, such as metabolizing lipids, could be swapped about 90 percent of the time. But few yeast genes involved in cell growth and death could be replaced with their human counterparts. Swappable genes, scientists conclude, are those involved in processes conserved during evolution. Species have tinkered with genes active in other types of processes. Those genes can't be swapped.

Yeast with large numbers of human genes could help researchers study responses to drugs or environmental conditions. — *Tina Hesman Saey*

Yeast processes and percent of swappable genes



SOURCE: A.H. KACHROO *ET AL*/*SCIENCE* 2015

EARTH & ENVIRONMENT

Global warming 'hiatus' an artifact

Skewed ocean data hid recent rapid increase in temperature

BY THOMAS SUMNER

One of the biggest mysteries of modern climate science may have never really existed, new climate analyses suggest.

Following decades of warming and a hot 1998, Earth's average surface temperature seemingly plateaued. This warming hiatus, as it came to be known, had climate researchers scrambling for an explanation. Now measurements and analysis by the National Oceanic and Atmospheric Administration suggest that the apparent hiatus was not an actual climate trend. Instead, it was an artifact of incomplete and biased data.

After correcting for biases in sea temperature measurements and filling gaps in land temperature data, the researchers report online June 4 in *Science* that the rate of recent global warming is more than twice as fast as once thought.

"The Earth is continuing to warm at a rate similar or higher than the rate over the last half of the 20th century," says Jay Lawrimore, a climate scientist at NOAA's National Centers for Environmental Information in Asheville, N.C.

The results make sense and demonstrate that the hiatus was overblown, says David Ridley, an MIT atmospheric scientist. This means climate simulations "haven't been as bad at predicting the temperature trend as people had begun to think," he says.

Decades of rapidly rising global temperatures culminated in 1998, the hottest year on record at the time. In the next 15 years, the warming trend appeared to slow to a crawl. The Intergovernmental Panel on Climate Change estimated in 2013 that the surface warming rate from 1998 through 2012 was around one-third to one-half of the average rate from 1951 through 2012.

While global temperatures have risen for more than a century, the rise hasn't been steady. Natural cycles cause temperatures to wobble from year to year. Many studies looked for a natural cause of the apparent warming hiatus, ranging from changing wind patterns (*SN: 3/22/14, p. 12*) to small volcanic eruptions (*SN: 8/13/11, p. 5*). But none fully explained the difference between the expected rapid warming and the observed slower trend.

Lawrimore and colleagues at NOAA instead looked for gaps and biases in the observational record. Long-term climate trends are stitched together from short-term weather measurements at thousands of locations. Some methods record slightly higher or lower temperatures than others, which can produce a fake trend when one method replaces another (*SN Online: 1/16/15*).

The team found several biases in the data. Fixing a few small biases actually supported the warming hiatus. But overall, correcting the biases increased the rate of recent warming.

The biggest bias concerned sea surface temperatures. Before World War II, sailors would scoop a bucket of seawater and take the water's temperature. Evaporation would cool the water as the bucket sat on deck, leading to artificially low temperature readings. Later, the preferred method shifted to measuring the temperature of seawater pumped in to cool the ship's hot engine, giving artificially warm measurements.

In recent years, researchers have switched to using more accurate ocean-monitoring buoys. Readings from these buoys are on average 0.12 degrees Celsius cooler than those from ships.

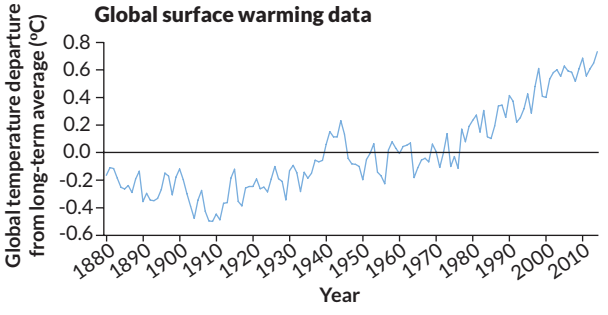
The researchers analyzed and updated the sea surface temperature measurements to account for the biases. Then the team added land surface measurements to the ones the IPCC had used. The new measurements included ones from the Arctic, where temperatures are rising twice as fast as at lower latitudes (*SN: 4/18/15, p. 13*).

In the new analysis, the observed rate of warming for 1998–2012 jumps from 0.039 to 0.086 degrees per decade. Shifting the time frame forward to 2000 through 2014, the hottest year on record, the warming trend increases to 0.116 degrees per decade, akin to the rate of the second half of the 20th century.

While the warming hiatus may have never existed, the research that hunted for a natural explanation for the pause still has value, says Shang-Ping Xie, a climate scientist at the Scripps Institution of Oceanography in La Jolla, Calif. Those studies have provided a better understanding of the forces that drive global and regional climate. Regional climate is especially important, he says, because "no one lives in the global average."

The new results also don't rule out the idea that natural forces can temporarily slow or halt global warming, says Joshua Willis, a climate scientist at NASA's Jet Propulsion Laboratory in Pasadena, Calif. Natural variability caused a lull in warming from about the 1940s through the 1970s. "Natural variations are here to stay," he says. "But we might reach a rate of warming that swamps those natural changes and you can't get the cooling anymore." ■

Warming unpaused Revamped climate data give a more accurate snapshot of recent global warming. The data dismiss the apparent slowdown seen since 1998 and show that the rate of recent warming has been on par with the trend seen in the late 20th century. SOURCE: NOAA'S NATIONAL CENTERS FOR ENVIRONMENTAL INFORMATION



E. OTWELL

HUMANS & SOCIETY

Hominid family gets new member

East African species lived near Lucy's kind, discoverers say

BY BRUCE BOWER

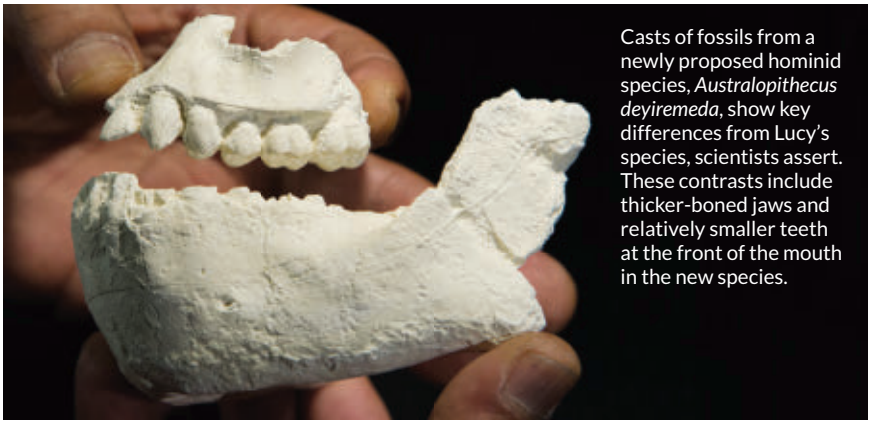
Here come the neighbors, Lucy. Scientists have discovered 3.5-million- to 3.3-million-year-old fossils possibly from a new species in the human evolutionary family. The species lived in what's now Ethiopia, near a hominid species best known for Lucy's partial skeleton.

A partial upper jaw and two partial lower jaws, one recovered in two pieces, belonged to *Australopithecus deyiremeda*, says a team led by Yohannes Haile-Selassie, a paleoanthropologist at the Cleveland Museum of Natural History. These finds support the view that two or more hominid species coexisted in East Africa before the dawn of the *Homo* genus, the researchers report in the May 28 *Nature*.

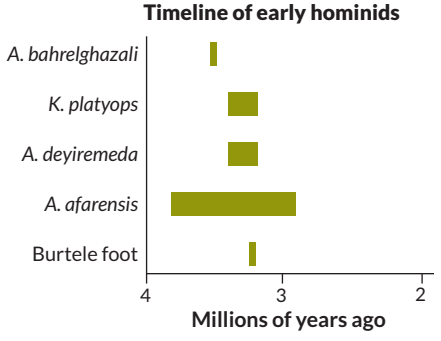
"The $64 million question is, what environmental and ecological factors triggered hominid species diversity between around 4 million and 3 million years ago," Haile-Selassie says.

The species name *deyiremeda* means "close relative" in the language spoken by people who live near the fossil site.

Fossils from *A. deyiremeda* turned up about 35 kilometers north of where Lucy's 3.2-million-year-old remains were found in 1974. Other fossils from Lucy's species, *Australopithecus afarensis*, date to between about 3.8 million and 2.9 million years ago.



Casts of fossils from a newly proposed hominid species, *Australopithecus deyiremeda*, show key differences from Lucy's species, scientists assert. These contrasts include thicker-boned jaws and relatively smaller teeth at the front of the mouth in the new species.



Same time, same place *Australopithecus deyiremeda* is one of several hominid species that may have lived in East and Central Africa at the same time as Lucy's species, *A. afarensis*.
SOURCE: F. SPOOR/*NATURE* 2015

LAURA DEMPSEY

Several features of the new fossils, including forward-situated cheeks, resemble those of a comparably ancient East African hominid, *Kenyanthropus platyops* (*SN: 3/24/01, p. 180*), writes paleoanthropologist Fred Spoor of University College London in the same issue of *Nature*. But *A. deyiremeda* looks more like Lucy's species at the front of the jaw, Spoor says.

A partial jaw and tooth belonging to another hominid from around Lucy's time, *Australopithecus bahrelghazali* (*SN: 12/15/12, p. 14*), are too fragmentary for comparisons, he says. Researchers found those fossils in the Central African nation of Chad.

Some investigators see the new fossils as representatives of Lucy's kind, not a separate species. Paleoanthropologist Tim White of the University of California, Berkeley says that *A. deyiremeda*, *K. platyops* and *A. bahrelghazali* show only minor differences from the skeletal pattern observed in nearly 400 *A. afarensis* fossils discovered over the last 40 years. "Lucy's species just got a few more new fossils," he says.

If current loose standards for defining hominid species were applied at the San Diego Zoo, "each mammal species would need five more cages," White says.

Haile-Selassie's team discovered what they regard as *A. deyiremeda* fossils where eroding soil had revealed the jaws. Dating of the finds rested on age estimates for volcanic ash just below the fossil-bearing sediment. Soil measurements of reversals in Earth's magnetic field and calculations of how fast soil accumulated at the site further refined the fossils' age.

A. deyiremeda displays generally small teeth and signs of a nearly flat face, much like early *Homo* species. But traits such as sturdy jaws and thick tooth enamel recall *Paranthropus*, an African hominid line that existed from about 2.5 million to 1 million years ago.

Those skeletal traits, and distinctively shaped teeth, separate *A. deyiremeda* from Lucy's species, Haile-Selassie asserts.

A 3.4-million-year-old partial fossil foot, known as the Burtele foot, previously discovered near the site of the new fossils might belong to *A. deyiremeda*, he adds. If so, then members of that species walked more clumsily than Lucy did, due to flat feet and grasping, gorilla-like big toes (*SN: 5/5/12, p. 18*). If not, then a third *Australopithecus* species may have inhabited the region.

A. deyiremeda might have been an ancestor of *Homo*, *Paranthropus* or *Australopithecus africanus*, a southern African hominid from roughly 3.3 million to 2.1 million years ago, Haile-Selassie suggests.

It's also possible that *A. deyiremeda* died out and left no descendants, comments Scott Simpson, a paleoanthropologist at Case Western Reserve University in Cleveland. Simpson considers the new fossils "reliably distinguishable" from Lucy's kind. ■

GENES & CELLS

Cancer mutations lurk in healthy skin

These genetic changes not always a sign of an imminent tumor

BY TINA HESMAN SAEY

By late middle age, about a quarter of skin cells may carry cancer-driving mutations caused by exposure to sunlight — and it's perfectly normal.

Researchers had previously thought that the types of mutations that fuel tumor growth were rare and happened just before a cell becomes cancerous. But a study of the eyelids of four people who don't have cancer reveals that such mutations "are staggeringly common in normal skin," says Philip Jones, a clinical scientist at the University of Cambridge.

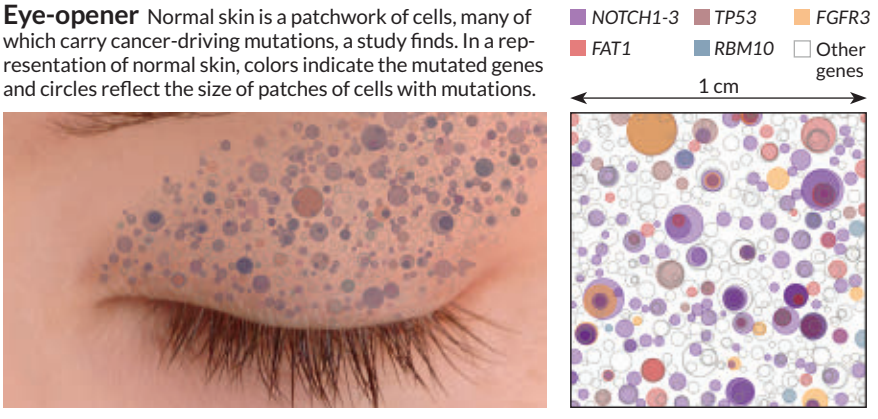
Jones and colleagues collected 234 skin samples from four people ages 55 to 73 who had plastic surgery to correct droopy eyelids. DNA sequencing showed that about 20 percent of the skin cells had mutations in the *NOTCH1* gene, the team reports in the May 22 *Science*. When mutated, that gene is a driving force in some cancers, including skin cancers called squamous cell carcinomas.

Other cancer-driving mutations were also present in the normal cells, sometimes with multiple mutations per cell. "What we see is not just a few, but many seeds of cancer already sown in that field," says coauthor Peter Campbell, a cancer geneticist at the Wellcome Trust Sanger Institute in Hinxton, England.

The new findings suggest that the line between normal cells and cancer is fuzzy, says Douglas Brash, a skin cancer researcher at Yale University. "There's really much more of a continuum than we thought."

Some of the mutations gave skin cells a competitive advantage over other skin cells. Cells with mutations that don't drive cancer formed patches of skin covering 0.15 square millimeters on average. Cancer-driving mutations in *NOTCH1* or a second gene, *TP53*, grew into patches averaging 0.23 and 0.33 square millimeters. The expansion creates more area for ultraviolet light to do further damage that might tip cells into becoming cancerous.

Still, even with cancer-driving mutations, cell growth was kept in check and cells behaved like healthy skin, Jones says. "The optimistic view is that our skin is astonishingly good at dealing with the inevitable damage caused by sunlight." Learning how the body reins in the cell growth could lead to improved cancer treatments. ■



Eye-opener Normal skin is a patchwork of cells, many of which carry cancer-driving mutations, a study finds. In a representation of normal skin, colors indicate the mutated genes and circles reflect the size of patches of cells with mutations.

FROM LEFT: I. MARTINCORENA; I. MARTINCORENA *ET AL*/*SCIENCE* 2015

BODY & BRAIN

Gene crucial for feeling pain found

Discovery may lead to better drugs for chronic sufferers

BY LAURA SANDERS

Mutations in a previously unscrutinized gene can leave people dangerously indifferent to harm, researchers report May 25 in *Nature Genetics*.

Certain changes to this gene, *PRDM12*, rob people of the ability to feel pain, leading to unintentional injuries such as scarred tongues or scratched corneas. A deeper understanding of how pain is blocked in these rare cases could ultimately lead to better pain treatments.

"It's promising, but there's a long way to go," says Simon Halegoua, a neuroscientist at Stony Brook University in New York.

Scientists already knew that mutations in another gene, *SCN9A*, can cause congenital insensitivity to pain (*SN: 6/30/12, p. 22*). In the new study, Geoff Woods of the University of Cambridge and colleagues identified 11 families that carry mutations in *PRDM12*. The gene encodes instructions for making a protein that helps pain-sensing nerve cells, called nociceptors, develop. Affected people are missing some nociceptor fibers that carry pain signals to the brain, the researchers found. "You need *PRDM12* present to grow your pain neurons," Woods says.

The PRDM12 protein helps orchestrate nociceptor development early in gestation, studies on human cells and frog and mouse embryos suggest. But the protein is also present after birth, hinting that it helps keep fully formed pain-sensing neurons working. The protein seems to be present only in pain cells and their precursors, as opposed to the protein made by *SCN9A*, which is found in the pancreas and some other locations.

"What's exciting is that this is probably the most pain neuron–specific gene that we know of," Woods says. That specificity raises tantalizing prospects for developing a drug that could tamp down chronic pain without causing problems elsewhere. "The more we can understand about how these nociceptors work," he says, "the more likely we are to have treatments for the vast numbers of people with chronic pain conditions." ■

EARTH & ENVIRONMENT

Titanic typhoons are in the forecast

Warmer subsurface waters may fuel bigger Pacific storms

BY THOMAS SUMNER

Warming waters may boost the destructiveness of future typhoons.

Studying 60 years of typhoon activity in the western Pacific Ocean, researchers spotted a clear trend: A typhoon's ultimate intensity largely depends on the temperature of deep seawater churned upward as the storm passes overhead. Projecting into the future, the researchers report May 29 in *Science Advances* that Pacific warming may hike the average typhoon peak wind speed 14 percent by 2100. That's enough to turn a Category 3 storm into a Category 4, notes lead author Wei Mei, a climate scientist at the Scripps Institution of Oceanography in La Jolla, Calif.

Faster winds spell trouble for anyone in a storm's path, says Kerry Emanuel, an atmospheric scientist at MIT. "A 14 percent increase in wind speed is an almost 50 percent increase in destructiveness."

Scientists expected that rising sea temperatures could intensify typhoons but were unsure how heat from subsurface water shaped the intensity of a typhoon season.

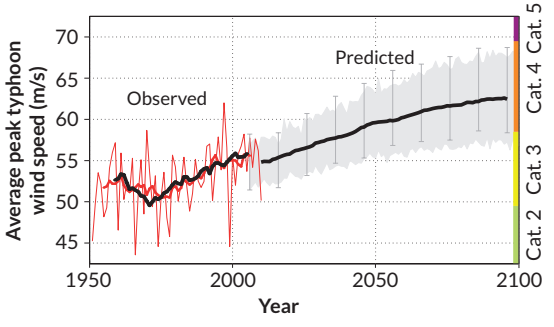
Mei's team compared the formation of over 850 historical typhoons. Slightly warmer waters 50 to 150 meters deep bolstered the strongest storm seasons.

Large storms churn up deeper water. When it reaches the surface, this water largely controls how much heat is available to power the storm. Since the mid-1970s, the average typhoon intensity has risen 10 percent as subsurface waters warmed by about 0.75 degrees Celsius on average, the team notes. With climate change expected to warm these subsurface waters about 1.3 degrees more by 2100, the team predicts that the average peak typhoon wind speed will increase from 198 to 225 kilometers per hour.

This prediction isn't the final word, says Thomas Knutson of the National Oceanic and Atmospheric Administration's Geophysical Fluid Dynamics Laboratory. Atmosphere-ocean interactions that weren't important during the last few decades could become more prominent in a warmed world and reduce typhoon intensity, he says. ■

Surging storms Warming subsurface ocean temperatures could raise the average typhoon wind speed by about 7.5 meters per second, enough to boost the average typhoon intensity from Category 3 to Category 4.

- Simulated nine-year running average typhoon intensity
- Observed typhoon intensity
- Observed nine-year running average typhoon intensity



ATOM & COSMOS

More clues to origins of supernovas

Dueling studies reveal two ways to trigger stellar explosions

BY CHRISTOPHER CROCKETT

There's more than one way to explode a star. Four recently seen type Ia supernovas show off this diversity. One supernova hints at the gas of a partner star fueling the explosion; colliding white dwarfs — the cores of dead stars — probably triggered the other three.

The observations, described in a pair of papers in the May 21 *Nature*, give astronomers a rare look at the first few days of a stellar detonation.

Shrapnel from one of the supernovas appeared to run into another star within hours of the explosion, astrophysicist Yi Cao of Caltech and colleagues report. The presence of this close stellar partner supports the idea that a relatively large star provoked a white dwarf to explode. The companion star may have dumped gas on the white dwarf until the added weight sparked a thermonuclear detonation.

The blast of gas then slammed into the companion star, creating a shock wave and an ultraviolet glow. The UV flash tipped off Cao and colleagues to the presence of the companion.

Astrophysicist Rob Olling of the University of Maryland in College Park and colleagues, however, saw no such bump in the light from three other supernovas captured by the Kepler space telescope. Kepler can't see UV light. But if another star had been lurking nearby, Olling says, the telescope should have seen something in the first few days after the supernova. The lack of a second flash supports another leading idea for what triggers the explosion — the collision of two white dwarfs locked in mutual orbit.

Evidence for different triggers "doesn't mean there's any problem," says Ryan Foley, an astrophysicist at the University of Illinois at Urbana-Champaign. "They're looking at very different physical systems." Olling's are run-of-the-mill type Ia supernovas that astronomers use to measure distances to other galaxies, Foley says. The explosion that Cao detected, however, "is a weird supernova." It's much less luminous and the debris doesn't fly away as fast.

Perhaps a star drizzling gas onto a white dwarf ends in a subpar supernova. A collision between white dwarfs, on the other hand, might lead to something with a little more oomph.

Sorting out how many supernovas are caused by each type of trigger is tricky because these explosions are rare, Olling says. "You have to look at lots of galaxies for a long time to find just a handful." ■

LIFE & EVOLUTION

Octopuses can 'see' with their skin

Even without eyes, body can sense light, trigger color changes

The California two-spot octopus (hatchling shown) can detect light with just its skin and then respond with a color-change display.

BY SUSAN MILIUS

Octopus skin can detect light and respond to it — no eyes or brain required.

Tests of fresh skin samples from California two-spot octopuses (*Octopus bimaculoides*) show this ability clearly for the first time in any cephalopod, says Todd Oakley of the University of California, Santa Barbara. White or blue light prompts the pale skin's tiny quick-change color organs, or chromatophores, to expand, creating waves of yellows and browns.

The octopus tests, along with another research team's new studies of two kinds of cuttlefishes and a squid, feed discussion about whether light detection in places other than eyes plays some role in cephalopods' changing color displays. All four species studied have light-sensing compounds in tissues beyond their eyes, the two teams report in the May 15 *Journal of Experimental Biology*.

Biologists have known that eyes and the central nervous system have a major influence on prompting color displays that camouflage octopuses or let them communicate. A paper in 1993 foreshadowed this, reporting that octopus skin itself also seemed to respond to light, Oakley says. His coauthor and UC Santa Barbara colleague Desmond Ramirez worked for months to determine that light triggers a color-change display in detached octopus skin samples. The researchers speculate that the eyes' main light-sensing protein, one of many forms of opsin, may also be active in skin as a sensor for light.

That idea fits with Ramirez's discovery that blue-green light prompts the quickest start for the skin samples' color changes. The light isn't very different, just 10 nanometers longer in wavelength, from the blue light (470 nanometers) that most strongly stimulates the eyes' opsin. Genes known to encode compounds that work with opsin also turn on in the octopus skin, the experiments show.

Opsins operating beyond the eyes might offer local refinements to camouflage or even help the animals sense other environmental cues such as pressure. These are intriguing ideas, but "it's early days," Oakley cautions.

Opsins and compounds that work with opsins also show up in skin from the common and broadclub cuttlefishes (*Sepia officinalis* and *S. latimanus*) and the longfin inshore

EARTH & ENVIRONMENT

Dolphin deaths linked to oil spill

Gulf of Mexico blowout may have led to lung, other injuries

BY BETH MOLE

The April 2010 Deepwater Horizon oil spill sparked a massive, ongoing die-off of dolphins in the Gulf of Mexico, a new study suggests.

Dead common bottlenose dolphins (*Tursiops truncatus*) examined in the region had lung lesions and adrenal gland damage, injuries previously linked to oil exposure, researchers report May 20 in *PLOS ONE*. Following the blowout at BP's Macondo well five years ago, researchers have tracked a rising number of unusual deaths and health issues in Gulf dolphins. But scientists have struggled to definitively pin the problems on the spill (*SN: 4/18/15, p. 22*).

"No feasible alternative causes remain that can reasonably explain the timing, location and nature of these distinct lesions and increases in deaths," lead author Stephanie Venn-Watson said at a news conference May 20.

Since early 2010, the number of stranded cetaceans (dolphins, whales and porpoises that are dead or in need of assistance) in the Gulf has nearly quadrupled. From 2002 to 2009, an average of about 74 cetaceans became stranded each year. As of May 31, 2015, the five-year toll had reached 1,398, or an average of about 280 strandings annually.

Venn-Watson, a veterinary epidemiologist with the National Marine Mammal Foundation in San Diego, and colleagues collected 46 dead dolphins from the Louisiana, Mississippi and Alabama coasts from June 2010 to December 2012. The researchers also examined records of 106 other dolphin deaths clearly not related to the spill, including some from the Gulf coasts of Florida and Texas that had occurred before the spill, plus others from North Carolina and South Carolina.

Of the spill-impacted dolphins, 33 percent had thinning of their adrenal gland cortex, which produces hormones essential for regulating metabolism and other functions. Only 7 percent of dolphins in the other group had such thinning. Adrenal gland abnormalities have been linked to oil exposure in mink and some kinds of birds.

Such damage could leave dolphins more vulnerable to infection and diseases, the researchers note. In fact, 22 percent of dolphins from the spill zone had bacterial pneumonia, compared with only 2 percent of dolphins not in the oil's path. "These dolphins had some of the most severe lung lesions I have ever seen in wild dolphins," said study coauthor Kathleen Colegrove,

MARKOS ALEXANDROU

Watch octopus skin react to light at **bit.ly/SN_octopus**

squid (*Doryteuthis pealeii*), Thomas Cronin of the University of Maryland, Baltimore County and colleagues report. The combination of compounds represents the first molecular evidence that opsins are functioning in the skin of these species. Molecular evidence also suggests a location in the skin: the chromatophores.

So far, though, there's no evidence in squids and cuttlefishes that light striking skin is enough to make chromatophores blush. Cronin isn't completely ruling out the idea yet and speculates about more subtle roles for skin opsins. "Maybe they don't respond directly, but they may alter a signal sent from the central nervous system," he says.

Research on light detection beyond eyes and brains "has been neglected for some time," says developmental biologist Florian Raible of the University of Vienna. Non-eye light-sensing structures or compounds also show up in the tube feet of sea urchins and the body walls of fruit fly larvae. And in Raible's lab, a polychaete worm flees light — even after beheading. ■

a veterinary pathologist at the University of Illinois at Urbana-Champaign.

Dolphins may be particularly vulnerable to lung damage from oil slicks because the animals take deep breaths at the surface and often hold their breath for long periods, which could extend exposure to toxic compounds, the authors say.

The lung and adrenal data for these dolphins are distinct from data for other dolphin die-offs, says Michael Twiner, a molecular toxicologist at the University of Michigan-Dearborn. Overall, the study makes a convincing link between the Deepwater Horizon oil spill and the health problems in the dolphins, he says.

Geoff Morrell, BP's senior vice president for U.S. communications and external affairs, disagrees. "This new paper fails to show that the illnesses observed in some dolphins were caused by exposure to Macondo oil," Morrell said in a statement. ■

BODY & BRAIN

Cerebellum may foster creativity

Activity in brain region grew while people played Pictionary

BY LAURA SANDERS

Creative sparks may fly from the brain's cerebellum. Activity in that part of the brain, once thought to be a plodding, steady workhorse, increased as people inside an fMRI scanner created Pictionary drawings, scientists report May 28 in *Scientific Reports*.

While other scientists caution that the brain-scan results lack the precision to say that cerebellum activity tracks with creativity, the study hints that the region plays some role.

"These are intriguing results, and it will be interesting to see how this relationship of cerebellum and artistic and intellectual creativity plays out in future studies," says neurologist Jeremy Schmahmann of Massachusetts General Hospital in Boston, who was not involved in the study. He says his clinical observations support the results: Two of Schmahmann's patients were artists who had their creativity sapped by strokes that damaged the cerebellum.

In the new study, 30 participants drew images meant to convey words such as "levitate," "pinpoint" and "exhaust" while undergoing brain scans. The more creative the drawing (rated by assessing originality, complexity and attention to detail), the more activity in the cerebellum, Manish Saggar of Stanford University and colleagues found.

Other brain regions involved in planning and organizing, including the cingulate and part of the left prefrontal cortex, seemed to get in the way of drawing images that conveyed words, the team found. Higher activity in those brain regions was linked with worse drawing performance, results that may help explain why focusing too hard on a task can sometimes seem to dry up creative juices.

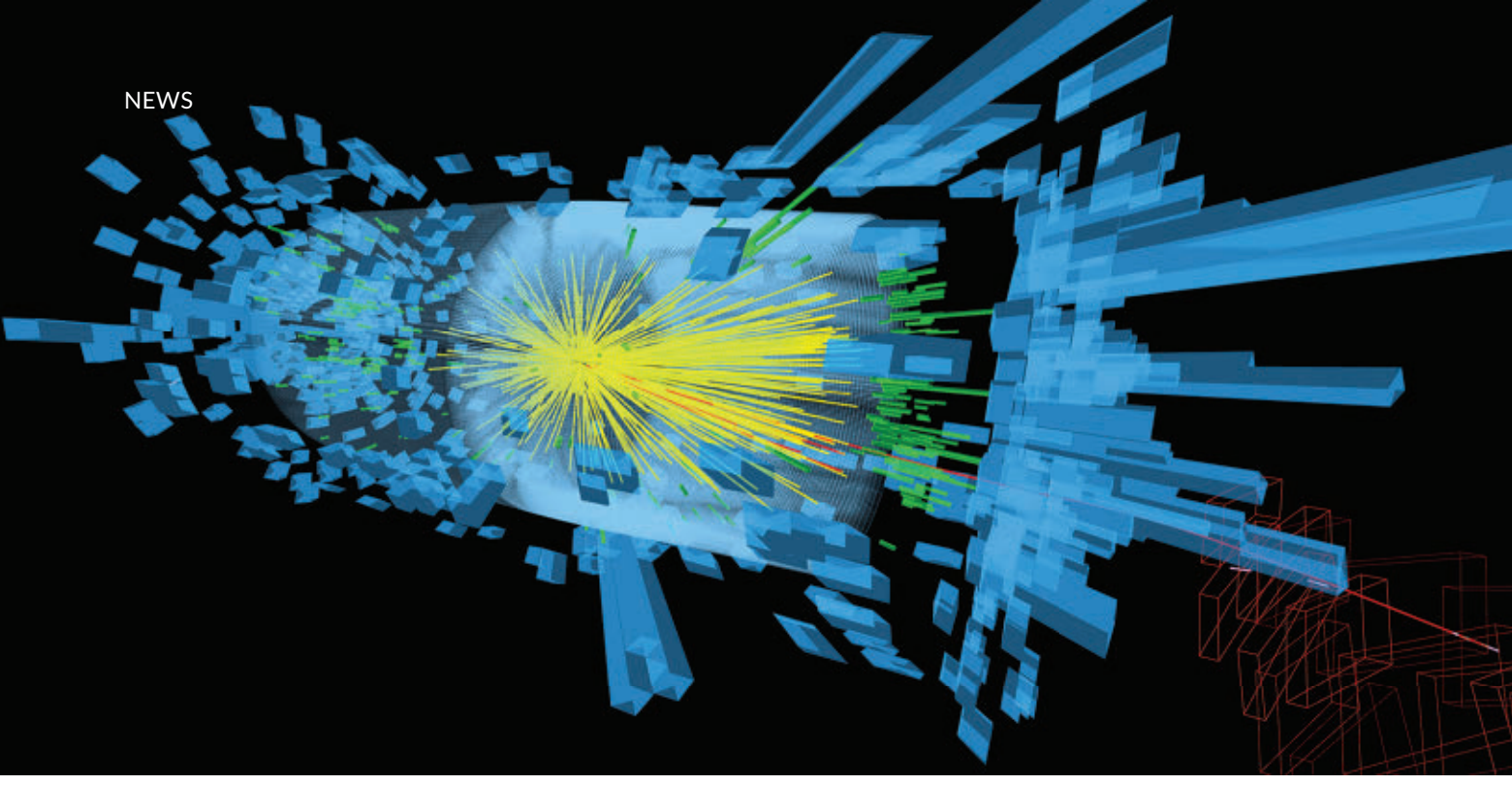
The cerebellum, a structure that sits at the base of the brain, is known for its role in controlling movement, a process that often happens without conscious effort. The cerebellum might also help generate ideas subconsciously, forming "part of the engine that pushes creativity," says study coauthor Allan Reiss, also of Stanford.

Other scientists urge caution in interpreting the results. Creativity is "quite difficult to capture in the wild," says Rex Jung, a neuropsychologist at the University of New Mexico in Albuquerque. It's possible that the cerebellum's activity might actually be tied to differences in movements of drawing elaborate scenes, not necessarily creativity, he says.

Neuroscientist Chris Miall of the University of Birmingham in England agrees that processes other than creativity might explain the results. The cerebellum activity detected could reflect differences in attention, word processing and working memory, he says. ■

Destination imagination
As participants in a new experiment came up with creative ways to draw verbs (examples shown), activity in the cerebellum increased.

COURTESY OF M. SAGGAR



A Large Hadron Collider detector tracks the paths of particles (yellow and red lines) created in collisions on June 3, the first day of data collection in over two years. Green and blue bars show the amount of energy left by particles.

CMS/CERN

ATOM & COSMOS

LHC set to see beyond Higgs boson

Next run of proton collisions seeks evidence of new physics

BY ANDREW GRANT

When researchers operating the Large Hadron Collider outside Geneva discovered the Higgs boson, it ended a decades-long effort to fill the final gap in physicists' catalog of matter's particles and forces (*SN: 7/28/12, p. 5*). Now comes the hard part. Physicists know that their catalog is only a start; there's far more to the universe that needs to be explained. But the LHC's first round of results offered no clues, no roadmap for delving beyond.

"We don't know how to link what we know to what we don't," says Tara Shears, an experimental physicist at the University of Liverpool in England.

An upgraded LHC began collecting data from high-speed proton collisions on June 3. After a two-year-plus hiatus, physicists are anxiously wondering whether the machine's second act will lead to discoveries of new particles and forces that add pages to the catalog.

"I'm cautiously optimistic," says Nathaniel Craig, a theoretical physicist at the University of California, Santa Barbara. "There's a significant likelihood of something happening."

Researchers say hints of new physics could come in the form of strange behavior of particles, a slightly peculiar Higgs or mysteriously disappearing energy. Those developments could show up soon after the machine restarts, or they may require a decade or more of painstaking analysis.

In the 1970s, physicists devised the standard model of particle physics, which showed how a set of puzzle pieces — particles of matter and particles that transmit forces — could fit together to form a coherent picture describing fundamental physical processes. By the time the LHC started its first experimental run in the spring of 2010, physicists had discovered all the puzzle pieces except one: the Higgs boson, which was needed to explain how some other particles acquire mass. Within a little more than two years, LHC physicists found the Higgs and completed the standard model puzzle.

> "The fact that the Higgs was the only exciting thing is a little disturbing."
>
> **KENNETH LANE**

The standard model beautifully describes ordinary matter, but it has no explanation for the vast majority of the universe's composition, which includes mysterious stuff such as the dark matter that dominates the mass of galaxies. Any strange finding at the LHC, such as an unexpected property of the Higgs or an oddly behaving set of particles, could have provided clues to particles and forces beyond the standard model. Yet the Higgs discovery was arguably the only highlight of the LHC's inaugural three-year run, disappointing physicists who hoped for more surprising discoveries. "The fact that the Higgs was the only exciting thing is a little disturbing," says Boston University theoretical physicist Kenneth Lane.

The lack of non-Higgs developments after more than a million billion proton collisions may seem to portend the same outcome as the LHC returns to action. Yet the revamped LHC is not a retread of the old one. LHC physicists are

colliding protons at a record-setting energy of 13 trillion electron volts, or 13 TeV, nearly doubling the energy of the machine's first collisions in 2010. Higher energy translates into an improved ability to produce and detect more massive particles. For example, the gluino, a proposed particle beyond the standard model that could weigh in at between 1 and 2 TeV, should stick out like a sore thumb in these collisions if it exists.

In addition to the energy upgrade, protons will also collide about a billion times a second, versus about 600 million collisions per second five years ago. The increased collision rate will allow experimentalists to more rapidly separate the signatures of new particles from the inevitable noise that comes when tracking a maelstrom of subatomic shrapnel.

Thanks to the dual improvements, over the next three years the LHC should produce about 10 times as many Higgs bosons as the roughly 500,000 churned out by the first-generation machine (only a fraction of those Higgs were actually detected). The boosted efficiency will enable physicists to meticulously probe every property of the particle and compare the measurements with standard model predictions. A discrepancy in, say, the rate at which the Higgs decays into photons would suggest that a particle or force new to physics is interfering with the process.

The Higgs could reveal new physics in other ways, too. Perhaps Higgs bosons are produced by yet-to-be-discovered heavier particles, says Matt Strassler, a Harvard University theoretical physicist. Or the Higgs might decay into lighter particles never seen before. Based on the limited number of Higgs bosons observed so far, Strassler says, "as many as one in 10 decays could be to something the standard model does not predict."

Strassler stresses that there is very good reason to believe that the LHC should find new particles. For one, the mass of the Higgs boson, about 125.09 billion electron volts, seems precariously low if the census of particles is truly complete. Various calculations based on theory dictate that the Higgs mass should be comparable to a figure called the Planck mass, which is about 17 orders of magnitude higher than the boson's measured heft (*SN Online: 10/22/13*).

As a remedy to this problem, many physicists have proposed new particles that essentially cancel out the influences that would otherwise cause the Higgs' mass to skyrocket. Those theories come in many forms and go by many names, including twin Higgs and supersymmetry (*SN Online: 10/17/13*). Despite the plethora of options, all these proposals hinge on the existence of particles with masses not much higher than that of the Higgs — a mass range that the supercharged LHC is optimized to explore.

Other physicists have high hopes that new physics is hiding in seemingly minor blips in measurements from the LHC's inaugural run. Lane and other theorists are eyeing decays of particles called B mesons. Some decays produce, among other things, electrons and positrons; other decays produce muons, which are about 200 times as massive as electrons but otherwise identical, and antimuons.

1
billion
Times per second protons will collide in the upgraded LHC

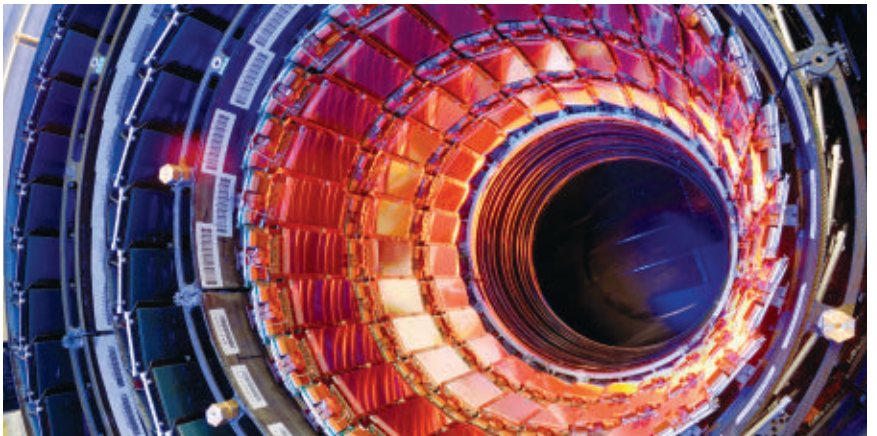
600
million
Times per second protons collided in the old LHC

According to the standard model, the B decays should produce muons just as often as electrons. Yet Lane says that multiple measurements suggest that only three muon/antimuon pairs are produced for every four pairs of electrons and positrons.

No single measurement meets physicists' strict statistical criteria to qualify as a discovery, Lane warns. But he says it's worth pursuing whether a new particle or force interacts preferentially with muons over electrons. Lane and colleagues also proposed that a B meson could decay into combinations such as one electron and one antimuon that are banned by the standard model. "That would be exciting as hell," Lane says.

Finally, the LHC could present a pivotal piece for the puzzle of dark matter. Physicists know dark matter exists because of its gravitational influence on galaxies (*SN: 5/16/15, p. 10*). But nobody knows what this mysterious matter is made of because it rarely, if ever, interacts with ordinary matter. Some theories of supersymmetry predict that the LHC should produce dark matter particles. While no detector would sense those particles, they could leave their mark if energy seems to mysteriously disappear following a collision. Strassler says that dark matter or related particles could decay into detectable matter. It's probably a long shot, but such a detection would offer that invaluable, elusive link between what physicists know and what they don't. ■

Physicists hope that upgrades to the Large Hadron Collider will lead to the detection of new kinds of particles. The collider's CMS experiment uses strips of silicon, seen here, to track the plethora of particles that are created during proton smashups.



MAXIMILIEN BRICE/CERN

HUMANS & SOCIETY

Stone Age killing is oldest whodunit

Pleistocene-aged skull bears earliest evidence of homicide

BY JULIA ROSEN

It's a classic murder mystery: no motive, no weapon, no suspect. Just a body, dumped in a remote location with fatal head injuries. It would be standard fare for an episode of *CSI* — except that it happened 430,000 years ago. That makes it the earliest documented case of homicide, researchers report May 27 in *PLOS ONE*.

The victim spent almost half a million years entombed in an underground cavern called Sima de los Huesos, or "Pit of Bones," in northern Spain. Since the 1970s, researchers have unearthed nearly 7,000 bone fragments from at least 28 individuals of the *Homo* genus (*SN: 7/26/14, p. 8*). And now scientists have uncovered the earliest evidence of foul play.

A skull known as Cranium 17 belonged to an otherwise healthy young adult who died from wounds that left two gaping forehead holes, says Nohemi Sala, a paleontologist at Centro Mixto UCM-ISCIII de Evolución y Comportamiento Humanos in Madrid. Sala's team pieced together 52 bone fragments from Cranium 17 to create a 3-D model of the skull. Then the team analyzed the fractures above the left eye to determine whether someone had it in for the victim.

The two holes are nearly identical in shape and size, suggesting multiple blows from the same weapon. By calculating the trajectories, the researchers determined that the blows flew from two different directions. It's hard to imagine that happening by accident, like in a fall, says Jörg Orschiedt, an archaeologist at the Free University of Berlin.

Prehistoric homicide appears to have been rare, says Haagen Klaus, an anthropologist at George Mason University in Fairfax, Va. The new discovery marks just the third potential murder case of the Pleistocene epoch, which ran from 2.6 million to 11,700 years ago. "If such violence was more frequent, then we would expect to see more evidence of it," Klaus says.

This 430,000-year-old skull was pieced together from fragments fished from a cave in Spain. The fossil exhibits signs of two injuries above the left eye, at least one of which was fatal.

Sala says it's challenging to find definitive proof of murder in the archaeological record. "We are not saying that this is the first time that it happened," she says. "This is the first time we can actually be sure." ■

LIFE & EVOLUTION

Dinosaur eggs came in multiple colors

Pigments found in fossils may offer insight into nesting habits

BY MEGHAN ROSEN

Dinosaur eggs had the blues.

Pigments detected in 66-million-year-old eggs from China suggest that the shells came in intense shades of bluish-green, scientists report online May 15 in *PeerJ Preprints*. Picking up on eggshell pigments could help scientists color in the details of dinosaurs' nesting habits.

"This is very, very cool," says paleontologist Luis Chiappe of the Natural History Museum of Los Angeles County. The authors' approach "allows you to reconstruct the original color of dinosaur eggs." No one has tried this before, he says.

Fossilized eggshells of the dinosaur *Heyuannia huangi* harbor pigments that would have colored the shells in shades of blue and brown.

Scientists had previously inspected dino fossils for hints of color: Ancient feathers may have glimmered iridescent or flashed shades of auburn and chestnut (*SN: 2/27/10, p. 9*). But no one had a clue about eggshell hues, says Martin Sander, a paleobiologist at the University of Bonn in Germany.

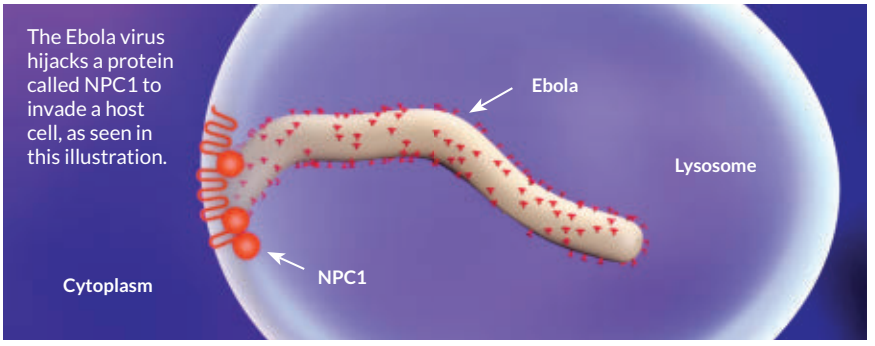
Sander, along with Jasmina Wiemann and other Bonn colleagues, thought fossilized shells might harbor remnants of color, too. The pigments that stain chicken eggs reddish-brown and robin eggs vivid blue are chemically stable molecules. So any pigments in dino eggs might not have crumbled away completely over time, Wiemann says. She analyzed shell slivers from fossilized eggs collected at three sites in China.

The eggs, stretched-out orbs about the length of Coke bottles, belonged to *Heyuannia huangi*, a short-beaked, crested dinosaur that looked kind of like a little emu. With mass spectrometry, Wiemann detected preserved pigments in different layers of the dinosaur's eggshells. These pigments could have dyed the eggs a spectrum of shades, from deep olive to brown-speckled blue.

The bluish color may have helped camouflage eggs laid in open nests, the authors suggest. The color also hints that dino dads helped with egg care, says Wiemann. Some modern birds that lay blue-green eggs rely on fathers to tend the nest.

The similarity between dinosaur and bird eggs is neat, Chiappe says. "It's another line of evidence that supports the idea that birds are living dinosaurs." ■

FROM TOP: JAVIER TRUEBA/MADRID SCIENTIFIC FILMS; J. WIEMANN *ET AL/PEERJ PREPRINTS* 2015



GENES & CELLS

Ebola gatekeeper protein identified

Ebola relies on a molecular "inside man" to sneak into cells.

Mice lacking the virus's accomplice, a protein called NPC1, are completely protected from Ebola infection, scientists report online May 26 in *mBio*. Designing drugs that target NPC1 could potentially stop Ebola from breaking and entering into human cells, study coauthor Kartik Chandran and colleagues suggest.

In 2011, Chandran, of Albert Einstein College of Medicine in New York City, and others identified NPC1 as Ebola's potential partner in crime (*SN Online: 8/24/11*). The protein rests in cell membranes and helps the virus slip out of lysosomes, a cell's garbage sacs, and into the cytoplasm. Once on the loose inside a host cell, Ebola can hijack the molecular tools it needs to multiply.

But scientists didn't know just how crucial NPC1 was for Ebola's dirty work. So Chandran and colleagues injected mice missing NPC1 with a mouse version of the virus. NPC1-free mice fended off Ebola completely — they showed no signs of the disease. Mice with the protein weren't so lucky: They died within nine days of the injection.

NPC1 typically transports cholesterol through a cell; without the protein, people can develop dementia. But the study's authors think Ebola patients could tolerate an NPC1-blocking drug because treatments would be brief. — *Meghan Rosen*

EARTH & ENVIRONMENT

Everest could lose most of its ice by the end of the century

Glaciers around the tallest mountain in the world may reach a historic new low relatively soon.

Combining projections of future climate with simulations of how glaciers melt and grow, researchers estimate online May 27 in *The Cryosphere* that the Everest region of the Himalayas could lose 73 to 96 percent of its ice by 2100. Seasonal glacial melt is a vital water source for people in the region, but the disappearing ice can also pose a serious natural hazard. Meltwater can stockpile behind debris dams before bursting downhill in giant, deadly floods. Such flood events have become more frequent since the 1940s, the researchers note. — *Thomas Sumner*

BODY & BRAIN

Mice become thin-skinned in space

Long trips in space may thin the skin. Three months on the International Space Station prompted mice skin to waste away and the animals' hair to grow, a new study shows. Scientists had hints that skin might be sensitive to weightlessness (astronauts frequently report skin injuries), but no one had analyzed the effects in such a long-term study before.

At 91 days in space, the astromice broke the record for weightlessness for nonhuman animals. The flimsy skin suggests that people may suffer similar damage on extended spaceflights. But because only three of six mice survived the trip, the findings are still preliminary, researchers report online May 27 in *npj Microgravity*, a new open-access journal. — *Meghan Rosen*

MATTER & ENERGY

Fingerprints reveal more than identity

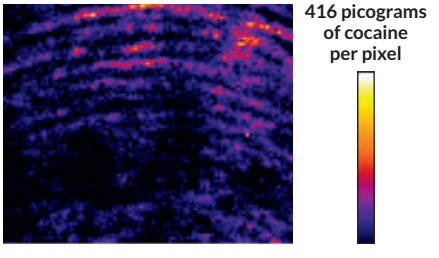
The one-of-a-kind pattern of ridges and valleys in a fingerprint may not only betray who was present at a crime scene. It may also tattle about what drugs a suspect handled.

With advanced spectroscopy, researchers can detect and measure tiny flecks of cocaine, methamphetamine and heroin — in some cases as little as trillionths of a gram — on a lone fingerprint. The work, led by researchers at the National Institute of Standards and Technology in Gaithersburg, Md., appears in the May 19 *Analytical Chemistry*.

Using an ink-jet–printed array of known quantities of drugs, researchers calibrated their spectroscopy techniques to measure specks of the chemicals. Then, using a 3-D printed plastic finger and a synthetic version of finger oil, the researchers created drug-tainted fingerprints pressed onto paper or silicon.

On paper, the team detected as little as one nanogram of cocaine and amounts above 50 nanograms of methamphetamine and heroin. On silicon, the method picked up roughly one nanogram of methamphetamine and as little as eight picograms of cocaine and heroin.

Researchers could also point to the location of the drugs on a fingerprint. Such information, the authors say, could help investigators finger what chemicals a suspect handled first and help corroborate a timeline of events in a crime. — *Beth Mole*



This fingerprint is laced with tiny traces of cocaine, as detected by a new method.

FROM TOP: ALBERT EINSTEIN COLLEGE OF MEDICINE; S. MURAMOTO *ET AL/ANALYTICAL CHEMISTRY* 2015

FEATURE

Pluto: Explored

New Horizons is very close to its long-awaited rendezvous with the dwarf planet

By Christopher Crockett

Tiny, far-flung Pluto is about to have a visitor — at least for a few hours.

On July 14, NASA's New Horizons spacecraft will reach the dwarf planet and try to learn all it can about Pluto and its five known moons. Then the probe will leave Pluto behind, vanishing into the frigid darkness beyond the planets.

In its wake, New Horizons will introduce Earth to the last of the "classical planets." Probes have flown past, orbited, crashed into or landed on every other world that orbits the sun. Now Pluto is getting its turn.

"This is the last picture show," says Alan Stern, the mission's leader. "It's the capstone moment to the reconnaissance of the planets."

Pluto is the doorway to the solar system's "third zone," the Kuiper belt, an icy junkyard beyond Neptune. Far from the meddlesome heat of the sun, Pluto swims in a sea of frozen fossils that are mostly unchanged since the birth of the solar system, 4.6 billion years ago.

New Horizons has been traveling for 9.5 years across nearly 5 billion kilometers to take a hard, if quick, look at Pluto and its icy neighbors. Cameras will chart the landscape on a world where the atmosphere may freeze for nearly 200 years at a stretch. They may find nitrogen volcanoes or hints of a bygone subsurface ocean. The probe will also explore why Pluto's tenuous atmosphere is leaking into space. Pluto's tiny moons may even provide a peek at what the building blocks of the planets look like.

Anticipation is building as the encounter to reveal Pluto's secrets draws near. "For a lot of people, this is something completely new — to see a point of light become a real place overnight," says Stern, of the Southwest Research Institute in Boulder, Colo.

"For a lot of people, this is something completely new — to see a point of light become a real place overnight."
ALAN STERN

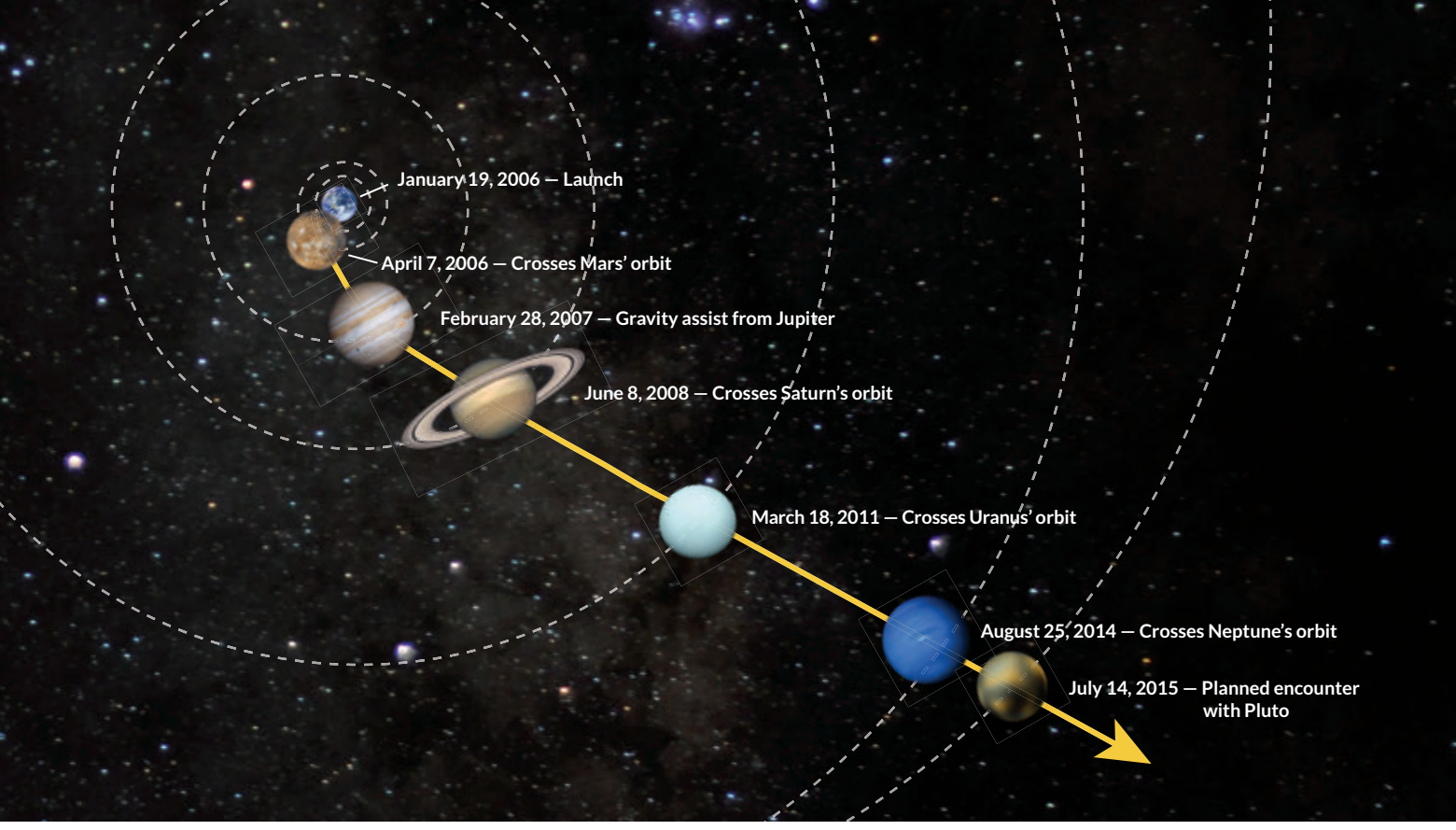
An odd little world

Flagstaff, Ariz., has a touch of Pluto fever.

Stroll downtown to a local coffee shop and you can order a Pluto Mocha. From there it's a five-minute walk to a sushi place for Pluto Rolls. A boutique around the corner sells handcrafted Pluto ornaments — one batch made before New Horizons' arrival and one planned for after.

Flagstaff is where Pluto's story began to be told. Near the center of town, on a mesa peppered with ponderosa pines, sits Lowell Observatory, where Clyde Tombaugh discovered the tiny world in 1930. About seven kilometers across town lies the

NASA, JHUAPL, SWRI



A long journey The New Horizons spacecraft (left page) launched in 2006 on a 9.5-year, 5-billion-kilometer trek across the solar system to spend a few hours with Pluto and its five known moons. The probe will tear past the dwarf planet on July 14 and provide humankind with its first intimate look at the remote world in orbit around the sun.

ADAPTED FROM NASA, JHUAPL, SWRI; PHOTO ILLUSTRATION BY M. TELFER. BACKGROUND IMAGE: NASA; EARTH: NASA; OTHER PLANETS: SEE PAGE 18

U.S. Naval Observatory Flagstaff Station, where in 1978 astronomer James Christy noticed a smudge of light cozied up to Pluto, which turned out to be its largest moon, Charon.

Our view of Pluto hasn't changed much over the last 85 years, despite debates about its worthiness of the title "planet." From Tombaugh's vantage point in Flagstaff, Pluto was a speck of light, slowly wandering against a backdrop of stars. And for the generations of astronomers with bigger and better telescopes that followed, Pluto has remained a mostly featureless spot on the sky.

Plans for visiting Pluto began in earnest in 1989. Several ideas for a mission came and went, but it was tough to justify flying to so remote a place. "I wasn't entirely certain what to think about the New Horizons mission," says Mike Brown, a planetary scientist at Caltech. "You learn by studying examples of things. If there was nothing else like Pluto, why go to this oddball?"

Pluto has always been an outlier, a diminutive ice-coated body on an orbit that carried it far above and well below the plane of the solar system. It even has the audacity to cross another planet's (Neptune's) orbit.

A fortuitous finding in 1992 kicked off a decade of discovery that finally made Pluto worth visiting. "What really put this over the top," Stern says, "was the discovery of the Kuiper belt." Planetary scientists David Jewitt and Jane Luu spied a small body orbiting beyond Neptune. It was the first confirmed body in the Kuiper belt, a long-hypothesized ring of frozen debris encircling the sun.

Pluto was no longer an oddball. It and Charon (Pluto's only moon known at the time) were emissaries from an uncharted realm of the solar system. Researchers have since cataloged more than 1,300 icy boulders tumbling about the Kuiper belt, a small sample of the trillion or so suspected.

With the discovery of the Kuiper belt, a National Academy of Sciences report in 2003 concluded that a mission to Pluto and Charon "should be NASA's highest priority for medium-size missions in the decade 2003–2013." Three years later — about eight months before the International Astronomical Union kicked Pluto out of the planet club (*SN: 9/2/06, p. 149*) — New Horizons was on its way.

Probe in a hurry

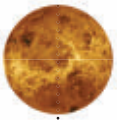
New Horizons launched on January 19, 2006, traveling about 58,000 kilometers per hour. It was the fastest spacecraft ever to leave Earth (at that speed a run from New York to Los Angeles would take about four minutes). New Horizons crossed the orbit of the moon nine hours after launch — a journey that took the Apollo 11 astronauts about three days.

The probe was in a hurry. Pluto has been moving farther from the sun along its orbit since

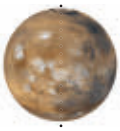
Meet the planets

Pluto is the last of the "classical planets" (and the first Kuiper belt object) to be explored. Every other planet had its first encounter with a spacecraft in a series of missions from 1962 to 1989. All but Uranus and Neptune have been revisited.

1960

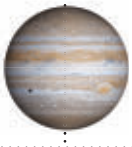


Venus
Mariner 2
December 14, 1962



Mars
Mariner 4
July 15, 1965

1970



Jupiter
Pioneer 10
December 4, 1973

Mercury
Mariner 10
March 29, 1974

Saturn
Pioneer 11
September 1, 1979

1980

Uranus
Voyager 2
January 24, 1986

1989. The already frigid temperatures — a warm day maxes out at −223 degrees Celsius — are dropping. Pluto gets so cold that its atmosphere might freeze for most of its 248-year trip around the sun. New Horizons needed to get there before 2020, when the atmosphere could become a giant ice shell, blocking the probe from studying the dwarf planet's surface and the dynamics of its atmosphere.

Unfortunately, it's impossible for the spacecraft to slow down and take its time once it gets to Pluto. It will cross the face of Pluto in just under three minutes but will be close enough to map the surface for a few days. The mission is nearly a decade of boredom capped with hours of terror.

The vessel has spent most of the trek to Pluto asleep. Once a year, mission engineers checked its instruments and electronics. In early 2007, New Horizons got its first in-space practice run as it sidled up to Jupiter for a speed boost. The planet's gravity grabbed the spacecraft and flung it into the outer solar system. At Jupiter, mission scientists did a little sightseeing, testing out the cameras and instruments on the giant planet and four of its moons.

After Jupiter, the spacecraft had almost eight years of cruising to go, silently crossing the orbits of Saturn, Uranus and Neptune. Finally, last December, engineers woke the probe at about 260 million kilometers from its destination (*SN Online: 12/8/14*).

"The spacecraft's in good health, on final approach," Stern says. "We're just on the cusp of where it gets interesting."

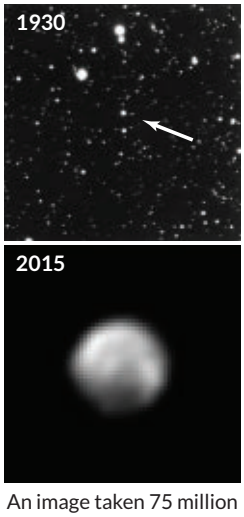
New Horizons moves more than 1 million kilometers closer to Pluto every day. The team is busy navigating the spacecraft, tweaking and testing the final sequence of commands, looking for hazards (see "Dodging debris," Page 20), finalizing the 150-plus software tools needed to analyze the data, and examining the first, still-blurry images of the fast-approaching world.

"It's all just ramping up together into this exciting frenzy," says Joel Parker, a planetary scientist also in Boulder, at the Southwest Research Institute. "We are starting to get data now. It's just going to be more and better from here on out."

On close examination

In January, early pictures began trickling in, showing a gradually brightening white smudge enveloped by darkness (*SN Online: 2/4/15*). Engineers use images snapped by New Horizons' telephoto camera, the Long Range Reconnaissance Imager, or LORRI, to keep the spacecraft pointed in the right direction, just inside the orbit of the moon Charon. The pictures also let scientists get a peek at their quarry. In July 2013, LORRI got its first look at Charon. Two other moons, Nix and Hydra, came into view in late January (*SN Online: 2/19/15*). The tiniest moons, Kerberos and Styx, finally revealed themselves in late April (*SN Online: 5/13/15*).

A sequence of images taken in early April showed the first hints of surface markings on Pluto itself, dark and light regions rotating in and out of view. A bright spot at the dwarf planet's north pole hints at a polar ice cap (*SN Online: 4/29/15*). About 60 days before the encounter, the LORRI images surpassed the resolution of the most detailed pictures of Pluto, captured by the Hubble Space Telescope. From mid-May to July 14, every subsequent image will be the best one acquired of the Pluto system.

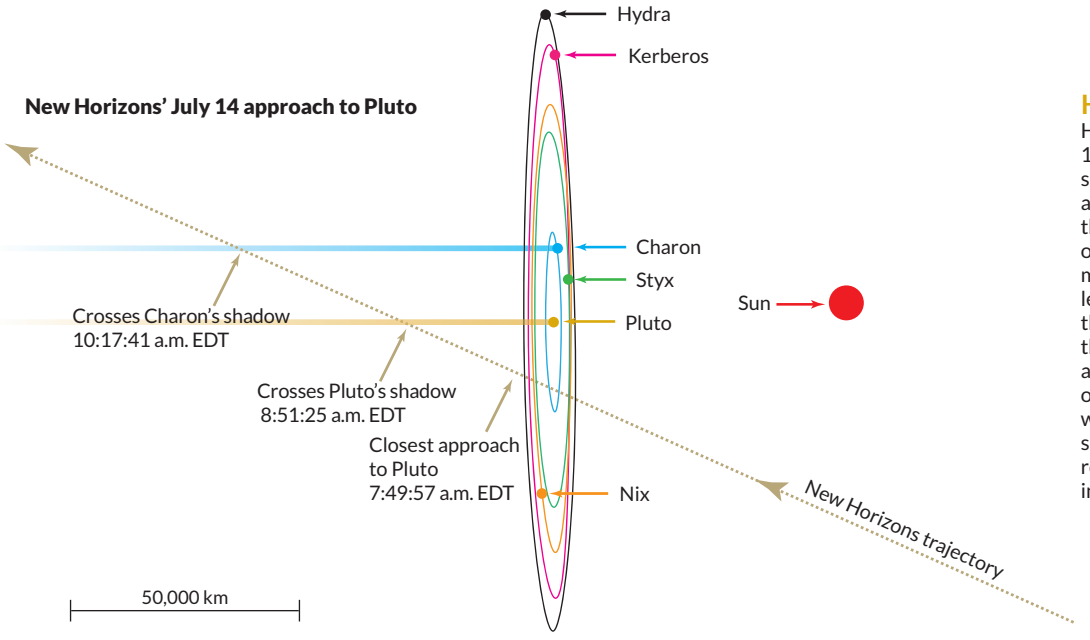


An image taken 75 million kilometers from Pluto (bottom) shows hints of details not visible in 1930.

As New Horizons closes in, its other instruments will start analyzing Pluto from afar. An ultraviolet spectrometer nicknamed Alice will study Pluto's atmosphere, examining its chemical makeup, density and temperature. Alice will also measure how quickly the atmosphere is leaking into space. The main camera, dubbed Ralph, will map the surface of Pluto and its moons (*SN Online*: 5/13/15), while LORRI zooms in for a more intimate look.

New Horizons' 2.1-meter-wide radio dish will serve double duty as a link to Earth and as another probe of Pluto's atmosphere. Two other instruments will monitor charged particles flying away from both Pluto and the sun. And a college

LEFT: JPL-CALTECH/NASA; JPL-CALTECH/NASA, MSSS; JPL-CALTECH/NASA, UNIV. OF ARIZ.; NASA, JHUAPL, CARNEGIE INSTITUTION OF SCIENCE; NASA AND THE HUBBLE HERITAGE TEAM (STSCI/AURA); JPL-CALTECH/NASA; CENTER: LOWELL OBSERVATORY (TOP), NASA, JHUAPL, SWRI (BOTTOM)



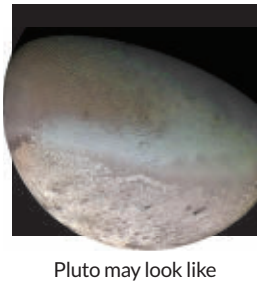
Hello/goodbye New Horizons will be about 12,500 kilometers from the surface of Pluto at its closest approach, flying along a path that takes it inside the orbit of the moon Charon (all five moons' orbits are shown at left). About an hour later, the probe will pass through the dwarf planet's shadow and witness a Pluto eclipse of the sun. The spacecraft will complete the trajectory shown here (a distance of roughly 240,000 kilometers) in about nine hours.

student–built detector — an array of plastic films the size of a cake pan — is recording impacts with interplanetary dust for most of the long trek.

On July 12 and 13, New Horizons will send highlights of its most recent investigations as a backup.

And then, silence.

For almost 24 hours, the spacecraft will stop communicating with mission control at the Johns Hopkins University Applied Physics Lab in Laurel, Md. It's a matter of priorities. To send back data, New Horizons needs to point its radio dish at Earth. But if the camera wants to aim at Charon, for example, the whole probe needs to turn. Time spent beaming information to Earth is time not spent studying Pluto and its moons.



Pluto may look like Neptune's moon Triton (shown), possibly plucked from Pluto's neighborhood.

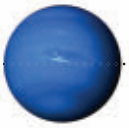
As New Horizons slips through Pluto's and Charon's shadows, the main camera will look for sunlight scattering off haze in the atmosphere or perhaps even faint rings of ice chips knocked off of Pluto's moons from collisions with space rocks. To take pictures of Pluto's nightside, the probe will use Charon as a mirror to bounce sunlight off Pluto's surface. Powerful radio antennas on Earth will blast a signal aimed at New Horizons, timed to skim Pluto's atmosphere. The degree to which the radio signal bends around the planet will tell researchers about the atmosphere's temperature and composition. The duration for loss of radio contact with Earth will provide a precise measurement of Pluto's (and Charon's) size.

If all goes well, New Horizons will phone home around 9 p.m. Eastern time on the 14th. It will send its first image on the following day, encoded in radio waves taking about 4.5 hours to reach Earth. Humankind will get its first up-close glimpse of one of the most remote worlds in the solar system.

That first glimpse might look a lot like Neptune's largest moon, Triton, which was probably snatched from the Kuiper belt long ago, when it got a little too close to Neptune. Triton has very few craters on a surface sculpted by ice volcanoes. Geysers belch nitrogen into the atmosphere, and expanses of terrain resemble the skin of a cantaloupe.

The Voyager 2 spacecraft, which launched in 1977 on a tour of the outer solar system, found Triton to be a changing world. Pluto may be similar. "I think we're all hoping to find some signs of active geology," says William McKinnon, a planetary scientist at Washington University in St. Louis. The large bodies in the Kuiper belt are planets in all but name, he notes. "They have histories, and geologies, and active atmospheres, and weather and all sorts of interesting things

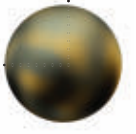
FROM TOP: NASA, JHUAPL, ADAPTED BY M. TELFER; CENTER: JPL-CALTECH/NASA, USGS; BOTTOM: NASA; NASA, ESA AND M. BUIE/SWRI



Neptune
Voyager 2
August 25, 1989

1990 ····· 2010

Pluto
New Horizons
July 14, 2015



Dodging debris

New Horizons can learn something from the *Titanic*'s epic collision: Watch out for chunks of ice. Mission control is keeping an eye out for such hazards and has a couple of backup plans, just in case. If controllers see debris ahead, and they have time to change the probe's trajectory, they'll go for Plan A: dive in close to Pluto and skim its atmosphere. Flying so close will make imaging the surface more difficult, but getting in closer should steer the probe clear of obstacles.

If it's too late to change course, then Plan B is a go: Use the probe's radio dish as a shield. Unlike the delicate instruments hiding behind it, the antenna can take some pounding. Controllers can turn the dish to face the debris and let it take the brunt of the impacts.

The odds of having to fall back on either plan are small, says Cathy Olkin, a planetary scientist at the Southwest Research Institute in Boulder, Colo. Mission planners chose a path that takes New Horizons close to Charon's orbit. The moon's gravity should sweep clear the road ahead. "But we have plans because it's responsible," she says. — *Christopher Crockett*

going on." The shape of Pluto, he says, may even betray the presence of a core or a hidden ocean: The more round it is, the more likely it's pliable, with an interior that's at least a little slushy.

If Pluto's atmosphere freezes, craters fill with ice, erasing any memory of past impacts. Charon, however, doesn't appear to have an atmosphere. So it might preserve a record of everything that's slammed into it over the last 4.6 billion years, which could provide clues to what else is flying around out there. "Everybody's excited for Pluto and overlooks poor Charon," Brown points out. "I think it's going to be the breakout star of the encounter."

In the end though, planetary scientists both on and off the Pluto mission's team just want to see what the place looks like. "I'm most interested in unwrapping the Christmas present and seeing the visual image," Stern says.

While the team is itching to see what Pluto is all about, there is a twinge of melancholy. After working on New Horizons for 26 years, says Stern, it will be strange to not be looking forward to its arrival. "For most of us," he says, "it's the only time we will be on a first mission of exploration where we go from knowing almost nothing to just a completely different universe, scientifically."

The mission doesn't end in July, however. The data won't finish downloading until late 2016 and will undoubtedly take years more to unravel. Plus, Stern and colleagues have plans for New Horizons to visit more distant shores.

Using the Hubble Space Telescope, scientists have identified two other potential stops in the Kuiper belt, each roughly 2 billion kilometers beyond Pluto. They lie in different directions, so it has to be one or the other. Stern says his team will make a decision with NASA in August, then fire up New Horizons' engines for the next phase of the journey.

Eventually the spacecraft will sail through the Kuiper belt and join four other spacecraft—Pioneer 10, Pioneer 11, Voyager 1 and Voyager 2—as Earth's ambassadors to interstellar space.

The Pioneer and Voyager probes carried with them mementos that are sure to befuddle alien salvage teams. New Horizons is no different. It's hauling two U.S. flags; state quarters of Maryland (where the mission was built) and Florida (site of its launch); a fragment of SpaceShipOne, the first privately funded, crewed spacecraft; two CD-ROMs, one carrying 434,738 names submitted by fans over the Internet and another loaded with pictures of New Horizons and its team; and a 1991 U.S. postage stamp emblazoned with the slogan, "Pluto: Not yet explored."

The ninth memento, attached to the spacecraft's interior wall, is a small container carrying a special passenger. One ounce of Clyde Tombaugh's ashes is along for the ride, honoring the man who spent countless hours comparing photographs of the night sky, looking for one little white dot moving among the stars. Its label reads: "Interned herein are remains of American Clyde W. Tombaugh, discoverer of Pluto and the solar system's 'third zone.' Adelle and Muron's boy, Patricia's husband, Annette and Alden's father, astronomer, teacher, punster, and friend: Clyde W. Tombaugh (1906–1997)."

The Flagstaff astronomer is finally getting to visit the world he discovered 85 years ago. ■

Clyde Tombaugh (shown) discovered Pluto in 1930 while searching for a planet hypothesized to be tugging on Uranus and Neptune. The New Horizons probe is carrying some of his ashes to Pluto and beyond.

DALE WITTNER/AP

Explore more

- New Horizons website: pluto.jhuapl.edu
- S.A. Stern. "The New Horizons Pluto Kuiper belt mission: An overview with historical context." *Space Science Reviews*. October 2008.

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COLD at HEART

Changing minds about how to treat criminal psychopaths

By Bruce Bower

Nudity, mind-altering drugs and encounter groups bring out the worst in psychopaths behind bars. That's not a pitch for a new reality television show — not yet, at least. It's an evidence-based conclusion. An infamous experimental treatment program for violent criminals, conducted mainly from 1968 to 1978 in a Canadian maximum security psychiatric facility 90 miles north of Toronto, tried those tactics to prepare men for life on the outside. Offenders with psychopathic personalities graduated from the program more violent than ever.

The results of that study played a big part in stoking fears, still common today, that psychopaths exploit psychological treatments to become better criminals. Mounting evidence indicates, however, that better-designed prison programs can help criminals with psychopathic personalities live less violently once released, says psychologist Devon Polaschek of Victoria University of Wellington in New Zealand.

In the Canadian study, prisoners participated in a "therapeutic community." Men developed their own rules and sanctions for misbehavior with little supervision. Rule breakers were confronted and challenged by their peers in prisoner-led therapy sessions. Those who adapted well to the system sat on committees that meted out penalties to others for bad behavior. Staff sometimes forced prisoners to spend days together naked in a room with wall-mounted feeding tubes. Men received alcohol, LSD and other drugs to help break down their psychological defenses during group encounter sessions. At the time, the study was considered a bold attempt to rehabilitate previously untreatable criminals.

It failed. Ten years or more after release from the facility, 78 percent of psychopaths who were tracked after graduating from the program had been arrested for further violent offenses, versus 55 percent of their untreated counterparts. Nonpsychopathic criminals did not become more violent after completing the unorthodox prison program.

Treatment backfired among psychopathic prisoners for good reason. Psychopaths in prison tend to get far more belligerent and aggressive when criticized or punished than nonpsychopathic criminals do, Polaschek says. Often glib and charming on the surface but callous and uncaring underneath, criminal psychopaths dig in their heels when harshly disciplined.

Unsurprisingly, psychopaths placed in the Canadian program broke far more than their share of community rules. The men — almost all guilty of violent crimes — got increasingly hostile as punishments piled up. A regular diet of harsh penalties made already violent psychopaths even more dangerous.

Current treatment programs for prisoners are nothing like the Canadian experiment. And the reasons go beyond a tightening of ethical standards. Treatments being tested today attempt to help prisoners readjust personal goals and control anger. This approach works best with nonpsychopathic criminals, but psychopaths appear to benefit as well. Simple computer programs show early promise in helping psychopathic prisoners, specifically, to see beyond their immediate needs and become more aware of those around them.

"Although criminals with psychopathy are among the hardest to work with, psychological treatment causes them, like other high-risk criminals, to reoffend less," Polaschek says.

Personality check

Modern notions of psychopathy have been heavily influenced by psychiatrist Hervey Cleckley. In 1976, he characterized psychopaths as masking a shallow and irresponsible nature with

PHOTO ILLUSTRATION BY E. OTWELL, BACKGROUND/BODIES: RUBBERBALL/SUPERSTOCK, MODEL FACES: SENSORSPOT/ISTOCKPHOTO

a confident demeanor. They could sometimes become violent or predatory.

Cleckley saw no hope for the psychotherapy of his time changing psychopaths' attitudes or behaviors. That conviction remains popular today, along with misconceptions of psychopaths as evil, homicidal villains akin to Charles Manson or fiction's cunning Hannibal Lecter (*SN Online: 1/14/14*).

Psychopathy is not an official psychiatric diagnosis, largely due to a lack of consensus on how to define this personality pattern in the general population. Clinicians today emphasize that people with psychopathic personalities can be fearless, impulsive, emotionally shallow, charmingly manipulative, hot-headed and cold-hearted. Psychologist Mark Olver of the University of Saskatchewan in Saskatoon and his colleagues use a 20-item checklist to determine which offenders have psychopathic personalities that create special problems for prison staff and treatment providers. The checklist, developed by psychologist Robert Hare of the University of British Columbia in Vancouver, covers four general areas (see table below).

Hare has estimated that psychopathic personalities characterize about 1 percent of the general population, with roughly equal prevalence in men and women. Research on psychopaths in and out of prison has focused almost exclusively on men.

"Psychopaths are not one type of person," Olver says. "Some are scheming and nonviolent, for instance, and others have emotional deficits and can be violent."

Olver splits violent psychopathic criminals into two broad groups: One group is callous, deceitful and emotionally shallow; the other is highly anxious and impulsive, his team reported in May in the *Journal of Abnormal Psychology*. With therapy that targets certain group-specific characteristics, both display comparable reductions in reoffending after treatment, he says. Olver's team found that rates of new violent crimes following release drop by 30 percent or more among psychopathic offenders who complete intensive, therapist-led group programs.

Psychopathic criminals receive the same treatment as other violent prisoners do, with adjustments based on individual needs. In what is known as cognitive-behavioral treatment, therapist-led groups work on ways to control anger and meet needs, such as feeling in control, without breaking the law.

If a particularly belligerent prisoner decides in group therapy, for example, to try calming down with a few deep breaths when frustrations arise during the day, prison staff may support his efforts. Physicians, cafeteria workers and others who cross paths with the man will give him time to collect himself during interactions. Staff members then report back to the therapist on what happened. Gradual behavior improvement may lead to a part-time job in the prison, providing more practice at dealing with others and handling frustrations.

Treatment is also provided, as needed, for alcoholism, drug addiction, depression and other mental ailments that can accompany psychopathy.

30
percent
Drop in new violent crimes among psychopathic offenders who complete intensive, therapist-led therapy versus those who don't

Therapists need patience, skill and a thick skin to work with psychopathic prisoners, Olver says. Having typically grown up as victims of various types of abuse, many psychopathic criminals arrogantly and deftly manipulate others without remorse, in his experience. These are not men who view psychological treatment favorably or form warm relationships with a therapist, Olver says. The goal is for each man to live peaceably among others and stay out of prison. That's success, even if many psychopathic offenders remain abrasive and emotionally distant after completing treatment.

"It's not illegal to be an asshole," Olver says. "It's illegal to beat people up and steal from them."

Olver's team tracked data on new offenses committed five to 10 years after release from prison by violent and sexual offenders in three previously published Canadian studies of cognitive-behavioral treatments.

Group treatments lasted an average of eight to nine months. In the largest study, 29 percent of 321 sex offenders had psychopathic personalities. Nearly three-quarters of those men completed treatment. An average of 10 years after being released from prison, roughly 60 percent of treatment completers had been arrested for violent crimes, versus 92 percent of men who didn't finish treatment. The disparity in re-arrest rates specifically for sex crimes was smaller: 42 percent for treatment completers versus 50 percent for the others.

In all three studies, rates of reoffending progressively dropped among psychopathic men who showed the most

Bad mix Clinicians and researchers often interview individuals for signs of psychopathy using a 20-item checklist of traits considered central to this personality type. People who score high in psychopathy can exhibit different mixes of these characteristics. Two lifestyle items are not shown below: sexual promiscuity and frequent, brief marriages. SOURCE: R. HARE, J. SKEEM *ET AL/PSPI* 2011

Psychopathy checklist

Interpersonal	Emotional	Lifestyle	Antisocial
Glibness/superficiality/charm	Lack of remorse or guilt	Need for stimulation/proneness to boredom	Poor behavioral control
Grandiose sense of self-worth	Shallow affect	Parasitic lifestyle	Early behavioral problems
Pathological lying	Callousness/lack of empathy	Lack of realistic long-term goals	Juvenile delinquency
Conning/manipulative	Failure to accept responsibility for own actions	Impulsivity	Revocation of conditional release
		Irresponsibility	Criminal versatility

improvement during treatment, Olver and his colleagues reported in the December 2012 *International Journal of Forensic Mental Health*. In one investigation, only 23 percent of men who responded well to treatment got arrested for further violent offenses, versus 57 percent of those who took poorly to treatment but completed it. Improvement during treatment was measured via observed behavior changes, such as a drop in explosive reactions when dealing with prison staff.

In a more than seven-year follow-up of 32 treated and 32 untreated violent, psychopathic offenders, treated men spent an average of 2.4 fewer years in prison for new offenses than untreated men. By Olver's calculations, that reduction in prison time would save more than $233,000 for each offender.

Reading context

Achieving the gold standard of treatment research — assigning psychopathic offenders at random to different programs or to no treatment — is nearly impossible. Yale University psychologist Arielle Baskin-Sommers and her colleagues have come close, though. They assigned psychopathic criminals to one of two computer-training courses to refocus the men's attention. One course may help deter future lawbreaking, Baskin-Sommers' team reported in the January *Clinical Psychological Science*.

Their approach is built on research led by psychologist and study coauthor Joseph Newman of the University of Wisconsin–Madison, who found that prisoners with psychopathy focus only on their own goals and ignore situational contexts. While working on simple memory or judgment tasks, for example, psychopathic criminals are not startled by sudden noises and they don't notice when images on the computer screen are mislabeled. That form of myopic, goal-oriented attention translates into, say, ignoring one's own nervousness while conning people out of their life's savings.

Baskin-Sommers' group randomly assigned 56 psychopathic inmates in Wisconsin to one of two computer-training programs. In one, participants learned to notice the context of experimental situations. For instance, the men viewed a series of mug shots and had to press a key on the right when the pictured person's eyes looked right and a key on the left when his eyes looked left. But when faces showed predesignated emotions, such as fear, the men had to switch their responses: If eyes looked right, push the left key; eyes left, push the right key. In the other training regimen, inmates practiced self-control, such as holding their breath despite discomfort and refraining from pressing computer keys in a game until after hearing a sound played through loudspeakers.

Inmates completed weekly one-hour training sessions over six consecutive weeks. By the program's end, the men doing context training got substantially better at those tasks. And they scored higher than before training on attention and emotional control tasks.

No such improvement occurred among psychopathic offenders who completed the self-control program. The researchers suspect that psychopaths' root problem is more about overfocusing on their immediate aims and ignoring consequences than overreacting to frustrations.

Baskin-Sommers' group plans to track study participants for the remainder of their sentences and after release from prison to see if context training leads to declines in criminal behavior.

"I suspect context training makes psychopathic offenders more receptive to other interventions," Baskin-Sommers says. Group treatments, such as those studied by Olver, might work

Callous kids

No one is born a psychopath. The last decade, though, has witnessed a burst of studies examining treatments for delinquent and violent youths who exhibit a strikingly psychopathic feature — little or no conscience.

These youngsters score high on a scale of callous-unemotional traits, including a lack of guilt and remorse, lack of concern for others' feelings, shallow expressions of emotion and not caring about much of anything.

Elevated callous-unemotional traits are found in 10 to 32 percent of children in community samples. Those rates remain fairly stable during childhood and early adolescence, says psychologist Paul Frick of the University of New Orleans.

But kids and teens are capable of changing as they get older. A 2007 investigation found that only about one in five 13-year-old boys who scored in the top 10 percent of callous-unemotional traits relative to their peers scored on the high end of psychopathy at age 24.

"A majority of callous-unemotional kids won't grow up to be psychopathic, but they have serious behavior and family problems and are at increased risk of entering the juvenile justice system," Frick says.

Six studies conducted from 2006 to 2013 demonstrate that children and teens high in callous-unemotional traits show a range of improvements after participating in intensive family and justice-system interventions, conclude psychologists Devon Polaschek and Jennifer Skeem of the University of California, Berkeley in the 2015 *Handbook of Psychopathy*.

One study tracked highly callous-unemotional teenage boys who were treated in juvenile facilities while serving sentences for violent crimes. Fifty-six boys received nearly a year of training in social skills, ways to form better friendships after release, strategies for dealing with authority figures and becoming less violent. Eighty-five boys received standard treatment, with medication assessments and psychotherapy or crisis intervention, if needed.

Of those who completed the intensive training, only 12 got arrested for violent acts over a two-year period after being released. In the standard treatment group, 42 boys were re-arrested for violent behavior after release.

even better with men trained to be clued into their surroundings. It's worth investigating, she suggests, and might reduce initial resistance to treatment programs.

Even if context training helps psychopathic offenders become less crime-prone, that doesn't confirm Baskin-Sommers' claim that myopic attention is a core part of their personalities and criminal behavior, remarks psychologist Scott Lilienfeld of Emory University in Atlanta.

Psychopaths display weak or no stress responses while awaiting fearful noises or disturbing images that they know are coming, Lilienfeld says. That type of anticipation typically sets off anxiety alarms in nonpsychopathic volunteers.

"The reason psychopaths don't attend to fear-provoking stimuli may simply be that they are not especially afraid of them in the first place," he suggests.

Even so, he says, if Baskin-Sommers' program lessens violence among psychopathic men released from prison, it won't matter whether context-blindness is a cause or a symptom of their problem.

Avoiding trouble

It's an open question whether context training on its own will make prisoners more law-abiding after release or more responsive to cognitive-behavioral treatments in prison. Further studies may support other types of computer training for psychopathic offenders, such as programs designed to improve recognition of emotional expressions on other people's faces.

Researchers also know virtually nothing about how some psychopathic ex-cons stay out of prison, even without psychological treatment. A small study of such men conducted more than a decade ago begs for a larger follow-up.

As part of his 2003 doctoral thesis, New Zealand psychologist Nick Wilson interviewed 14 psychopathic men who had avoided prison time for five years after serving sentences for murder, sex offenses and other serious crimes. Many of the men had moved to rural spots, far from illegal temptations and hard-scrabble buddies. Most were unemployed but had wives or girlfriends who worked and discouraged alcohol and drug binges. Ex-cons continued to think about committing serious infractions and two admitted having manipulated younger men into carrying out crimes.

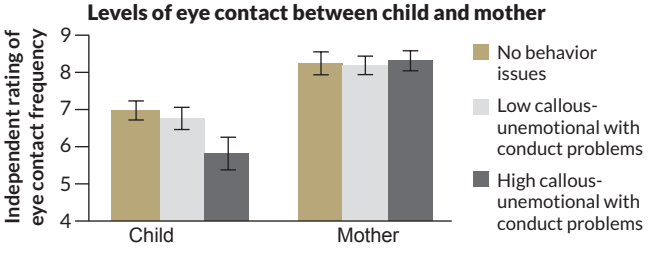
But a desire to escape the indignities of prison kept psychopathic offenders from directly acting on their worst thoughts, concluded Wilson, now at the Department of Corrections in Hamilton, New Zealand.

Olver recalls treating a psychopathic offender who fit that bill. A big, burly man, he frequently threatened to hurt others and gave in to urges to peep into strangers' windows and seek sex with underage girls. The man developed some strategies for controlling his impulses in treatment and got a job after leaving prison. Despite those achievements, he confided to Olver that he still couldn't bring himself to care about what happened to other people.

But knowing what it would be like to grow old alone and behind bars provided a reality check, Olver says. "He just wanted to avoid coming back to prison." ■

Explore more

- Devon Polaschek. "Adult criminals with psychopathy: Common beliefs about treatability and change have little empirical support." *Current Directions in Psychological Science.* August 2014.



Eye Spy Callous-unemotional kids with conduct problems looked their mothers in the eyes less than well-behaved kids and less than kids with conduct problems who had few callous-unemotional traits (left). Mothers of callous-unemotional children tried to make eye contact as much as other mothers did (right). SOURCE: M. R. DADDS *ET AL/J. CHILD PSYCHOL. PSYCHIATRY* 2014

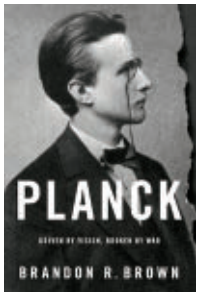
For younger kids who are highly callous-unemotional, help may come in the form of a skill that seems natural to most children — looking their mothers in the eyes, suggests psychologist Mark Dadds of the University of New South Wales in Sydney.

The children's lack of concern for others appears to be intimately tied to an early derailment of eye contact, Dadds proposes. In the July 2014 *Journal of Child Psychology and Psychiatry*, a Dadds-led team reported that 16 highly callous-unemotional 4- to 8-year-olds with severe behavior problems spent little time gazing into their mothers' eyes during mutual play. In the same study, 44 kids who often misbehaved but also showed concern for others and genuine emotions maintained good eye contact with their mothers.

Averted gazes may emerge surprisingly early in kids. Five-week-olds who pay little or no attention to an experimenter's face moving in front of them are particularly likely to score high on callous-unemotional traits at age 2.5 years, reported psychologist Rachael Bedford of King's College London and her colleagues in 2014 in *Biological Psychiatry*.

Much research indicates that eye contact between adults and children supports the development of conscience and empathy, Dadds says. He is studying whether callous-unemotional kids get along better at home and at school after four months of training in making eye contact with their mothers. Results are due later this year.

— Bruce Bower



Planck
Brandon R. Brown
OXFORD UNIV., $29.95

BOOKSHELF

Max Planck, originator of quantum theory, tormented by war and personal loss

Scientists are products of their times and their culture. Some see beyond those constraints. Some are trapped within them. Max Planck was trapped, as physicist Brandon Brown relates, and therefore could not escape from the turmoil of Germany's wars.

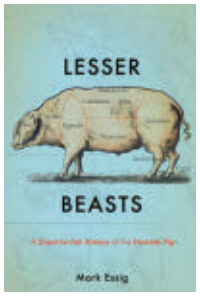
In an unusual approach to a scientific biography, each chapter heading of *Planck* selects a month during the final four years in the life of the scientist, who died in 1947 at age 89. His story is told through flashbacks to various points in his distinguished career as the godfather of modern German science.

Planck's story is a sad one. Nearly all of his family — first wife, sons, daughters — predeceased him, through illness, war or execution (of his son Erwin, who had links to some of those engaged in the plot to kill Hitler). Even Planck's greatest scientific achievement — the discovery of quantum theory — was bittersweet, as he resisted accepting the implications of quantum physics discerned by Einstein, Bohr, Heisenberg and others.

In his account of Planck's life, Brown emphasizes the personal over the professional, especially probing the conflict Planck faced during the Nazi years. Obsessed with optimism, Planck persistently told himself everything would be OK as he acquiesced in the purge of Jewish scientists. Deep down, it seems, Planck knew the wrongness of it all, but his allegiance to the state overwhelmed any impulse he might have had to stand up, speak out or leave. Still, Planck was revered by his scientific colleagues and his name adorns all of Germany's major research centers today.

Brown's flashback approach makes the arc of Planck's life a little hard to follow. And the book's science often lacks depth (except for a technical appendix). Some explanations are scientifically sketchy — for instance, quantum-entangled particles do *not* communicate faster than light, as Brown writes. Analogies are frequently strained ("the mathematical bus of Planck and Einstein was leaving [others] of the physics world coughing with exhaust fumes").

But on the whole, this biography looks more deeply into the mind and personality of its subject than many scientific biographies. And Planck's life is worth examining for the lessons it illustrates about scientists working within a society that values ideology over intelligence. — *Tom Siegfried*



Lesser Beasts
Mark Essig
BASIC BOOKS, $27.50

BOOKSHELF

Pigs don't deserve the name 'Lesser Beasts'

If humans have a counterpart in the rest of the animal world, it is surely the pig.

As historian Mark Essig writes in *Lesser Beasts*, perhaps no other animal's history more closely mirrors that of humans. From the appearance of semitame *Sus scrofa* living with hunter-gatherers 11,000 years ago in Turkey to the role of swine in the rise and fall of empires, the story of the pig is also the story of modern humans.

The traits that made domesticated swine so numerous are the same ones that have helped humans become the dominant species on Earth: cleverness, omnivorousness and adaptability. Like a pig unearthing acorns, Essig overturns gem after gem of hog history, and he peppers them with humor and empathy.

The human-pig relationship has sometimes been almost comical, as during medieval times, when swine were put on trial for murder or for disobeying Sabbath laws. The relationship has also been religious, as in boar-themed holy garments from Celts and Norse. Most of all, it has been bountiful. Whether by saving ancient Egypt's poor from starvation or enabling the conquistadors' march across the Americas, the pig greased the skids of civilization.

When Spanish explorer Hernando de Soto stepped ashore in what is now Florida in the mid-1500s, he traveled with hundreds of soldiers but just 13 pigs, the first to reach North America. De Soto gave his hogs first-class treatment, and it worked. When he died three years later, his swine herd numbers had swelled to 700.

Within a couple of hundred years, pigs in colonial America had become "agents of empire," Essig writes. They devoured wild foods and inadvertently helped destroy Native Americans' way of life.

Today, factory farms churn out pork at the fastest rates in history. But recently, Essig writes, many people have become uncomfortable with the factory farm standard of sows spending most of their lives in crates. Some nations have mandated that pigs have more space and access to rooting material.

Perhaps growing discomfort with some farming techniques comes alongside recognition of pigs' humanlike behavior. In tests, the animals display an understanding of how mirrors work, learn to sneak extra helpings of food and play video games. — *Teresa Shipley Feldhausen*

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This Is How To Walk the Walk

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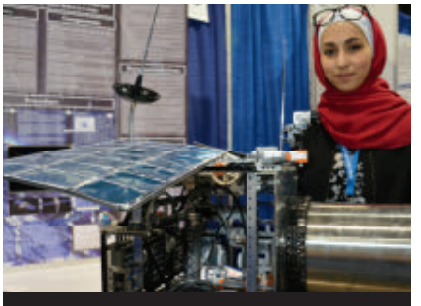
Spotlight ON STUDENT SCIENCE AT Intel ISEF 2015

In May, the 2015 Intel International Science and Engineering Fair gave students from around the world a chance to share their scientific research and inventions. The competition, sponsored by Intel and run by Society for Science & the Public, brought 1,702 teens to Pittsburgh from more than 70 countries for a weeklong science fest. *Science News for Students* took a closer look at some of this year's finalists and their projects.

Collecting trash in space

Satellites play big roles in modern life. But these marvels of technology can be knocked out by a collision with space junk — debris from satellites and other Earthly technology orbiting the planet. Now, a teen from Jordan has designed a satellite to chase down space junk, collect it and then dispose of it.



Dana Arabiyat designed a satellite (model shown) to collect and dispose of the space trash that threatens other satellites orbiting Earth.

Some 100 million pieces of debris orbit Earth today, says 15-year-old Dana Arabiyat, who attends Alridwan Schools in Amman, Jordan. This debris orbits the planet at speeds of up to 28,200 kilometers per hour.

Here's how Arabiyat's satellite would work: A radar system aboard the satellite would scan for and find a piece of space junk. Then, thrusters would change the satellite's orbit so it could chase down the errant object. As the satellite closed in on its prey, cameras would keep it on target. At the last minute, a door that leads to a bulletproof container would open. This container needs to be strong so that it doesn't break apart when the satellite swallows the space junk, Arabiyat explains.

When the trash container was full, it would be lowered toward Earth on a kilometers-long cable and its contents released into the upper atmosphere. There, the space junk would harmlessly burn up just like a meteor does. Meanwhile, the satellite would reel the container back up so that it could collect more trash. — *Sid Perkins*

This door handle kills germs

A sick person can leave behind bacteria or viruses when touching a doorknob, handrail, shopping cart handle or countertop. Anyone else who touches that surface may pick up the microbes. So two teens from Hong Kong developed a door handle that can knock out germs on contact.

Door handles in public areas often host lots of bacteria and viruses, notes 17-year-old Sum Ming Wong. The 10th-grader attends Church of Christ in China Tam Lee Lai Fun Memorial Secondary School in Tuen Mun, China. He and schoolmate Kin Pong Li, 18, wanted to design a coating for door handles that would be hostile to germs. To make their coating, they chose titanium dioxide, a mineral known to kill bacteria.

Titanium dioxide works best when lit by ultraviolet light, says Wong. So the teens decided to light their door handle from within. They fashioned the handle from a long cylinder of clear glass. Each end fits into a bracket. Inside one of the brackets is a strong LED that emits UV light. And here's the nifty part: The power for the light comes from opening and closing the door. Wong and Li designed a small gearbox that attaches to the door. Equipment inside the box converts the motion of those gears into electrical power. That power is then carried by wire to the LED inside the door handle. In lab tests, their UV-lit coating killed about 99.8 percent of germs.

The door handle system, the teens say, might cost no more than about $13 to build. — *Sid Perkins*

Making windshield wipers obsolete

Windshield wipers sweep raindrops and snowflakes off the glass so drivers can clearly see the road. But one day high-speed flows of air from well-placed nozzles might prevent precipitation from ever striking the windshield. That's the idea behind a new technology designed by a pair of 16-year-old inventors.

Wiper blades eventually wear out, say Eric Breuer and Florian Maly, 11th-graders at the École Privée Notre-Dame Sainte-Sophie in Luxembourg. And even when new, wipers sometimes can't keep up with heavy rains. So Breuer and Maly designed a system to blow a stream of air across a windshield to keep rain and snow from reaching the glass.

The pair tested their ideas in a wind tunnel on a one-eighteenth scale model of a car. They created a nozzle that uses two plates of metal separated by a small distance. The air spews from a long, narrow slot that's as wide as the windshield. When the teens forced high-pressure air though this nozzle, it blew air evenly across the model's windshield. To simulate rainfall while driving, they turned a spray of water from a hose onto their model.

For a wind speed of 50 kilometers per hour, the nozzle worked best when blowing up and forward at an angle of 45 degrees, the teens found. When moving at some other speed, a different angle might work better. So any system installed on an actual vehicle would need to be adjustable. The angle could easily be controlled by an onboard computer and change with the vehicle's speed, the young researchers say. — *Sid Perkins*

BOTH: LAURA BUITRAGO/SSP

Studying? Don't answer that text!

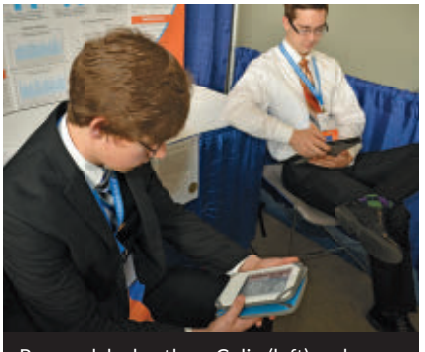
Texting affects learning and performance on tests, two teens have found. On average, students who responded to texts while working got lower scores. This trend held even for teens who felt they could multitask effectively.

Many students think that multitasking has no effect on how they perform in school, says Colter Norick, 17. So the Montana teen and his 16-year-old brother Colin recruited 47 classmates at Columbia Falls High School to take part in a two-phase experiment. Each participant had to read a paragraph or two and then answer a question about the passage.

In the first phase, the volunteers encountered no distractions. Later, the researchers had their recruits tackle a new set of readings. This time, a computer program sent texts to the volunteers' cellphones every 90 seconds. Each text asked questions that required a reply.

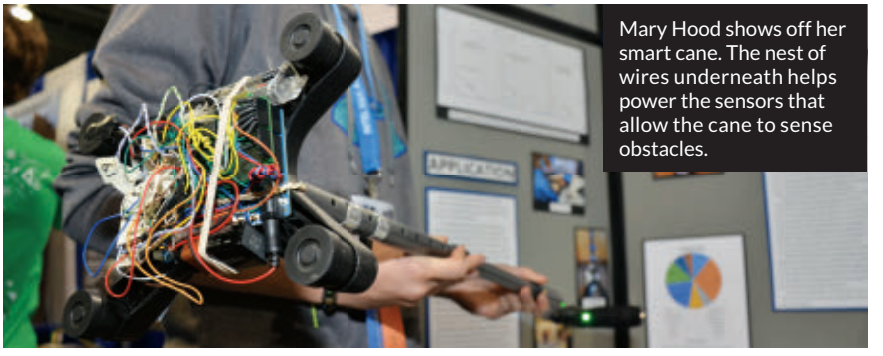
Test scores should have been higher on the second test because it was slightly easier. But the recruits scored 9 percent worse overall when distracted by incoming texts. Only a few students scored as well when replying to texts as they did when uninterrupted. But nobody performed better during the texting phase.

It didn't matter if a student thought he or she was good at multitasking. On average, the brothers found that even students who were confident of their abilities did just as poorly on the test while texting. — *Sid Perkins*



Research by brothers Colin (left) and Colter Norick (right) found that students who respond to text messages while taking a test end up with lower scores.

BOTH: LAURA BUITRAGO/SSP



Mary Hood shows off her smart cane. The nest of wires underneath helps power the sensors that allow the cane to sense obstacles.

Stepping out with a smarter cane

As people get older, they can have a tough time getting around. But one teen showed that sometimes technology can keep seniors up and moving.

Mary Hood, 17, has developed a cane that senses stairs, curbs and other potential hazards. It also tracks its users' heart rates, reminds them to take their medication and even lights the path ahead. "I guess I got the idea from my grandma," says Hood, a junior at Sargent High School in Monte Vista, Colo. "She's 84 and she's visually impaired. I felt that technology could really make a difference for her."

Hood's new "smart" cane is full of sensors. Some measure elevation by sending out tiny pulses of a high-pitched sound. That sound bounces off objects ahead, such as a coffee table, and then returns to the sensor. If the cane gets too close to an obstacle, its sensors make the handle vibrate, warning the walker to watch out.

Gripping the cane's handle provides data on how fast a user's heart is beating. If a heart rate is too high or too low, the user may be at risk of fainting. So the cane will vibrate and let its user know that it's time to find a seat and rest. The cane can also be programmed to notify users when it's time to take medication.

Hood wanted her cane to appeal to older people who might need it. "That's why the alert method is through vibration," she explains. "I chose that because it's tactile. So if you can't hear a buzzer or see a light you can feel the vibration." — *Bethany Brookshire*

Keeping roofs cooler to cut energy costs

A paintlike coating could keep roofs cooler during summer, a teen researcher finds.

Shingles come in many colors, but dark ones are especially popular, says Jesseca Kusher, 18, of Spartanburg Day School in South Carolina. But dark shingles absorb a lot of heat. In the summer, they can easily reach 73.5° Celsius, she notes. If the shingles reflected more sunlight, they'd stay cooler, helping cut down on home cooling bills.

So Kusher looked into ways to make shingles reflect more light. She mixed tiny particles of three different substances — graphite, gypsum or mica — into a clear coating and painted each of her concoctions onto bits of shingles. To simulate how the shingles would heat up in summer, she placed each postage stamp–size sample under a 150-watt sun lamp. The samples were irradiated for 15 minutes, or until the untreated shingles reached a temperature of 73.5°C, whichever came first.

Powdered mica had the best overall cooling effect. Shingles with this coating only heated up, on average, to about 58.5°C. Shingles coated with powdered gypsum or graphite got a bit warmer on average.

The new coatings might also cut the formation of lung-irritating ozone in cities, says Kusher. Cities often get warmer than rural regions nearby. That extra heat can speed up chemical reactions in the air, some of which create ozone. Cooling off a lot of urban roofs could decrease ozone production, Kusher speculates. — *Sid Perkins*

MAY 16, 2015

Water from space

A barrage of icy asteroids might have brought water to Earth. In "Water, water everywhere" (SN: 5/16/15, p. 18)*,* ***Christopher Crockett*** *described how planetary scientists are piecing together the origin story for Earth's abundant H_2O.*

To figure out where Earth's water came from, researchers looked at the ratio of hydrogen to a heavy form of hydrogen called deuterium in water samples from asteroids and comets. But reader **Daryl Dubas** noted that lots of chemical processes, like photosynthesis and respiration, can create and break down water molecules. "Is it not possible that these processes have some sort of predisposition towards using or creating certain variants of the water molecule that changes the deuterium-to-hydrogen ratio over time?" he asked.

Cosmochemist **Conel Alexander** of the Carnegie Institution for Science in Washington, D.C., responds: "The Earth is a geologically and biologically active planet that will have reworked the water many, many times." But this wouldn't have changed the overall deuterium-to-hydrogen ratio of Earth, he adds. Hydrogen and deuterium show up in many molecules, not just water. Deep in the Earth, for example, most of the hydrogen is stored in hydroxide ions within silicate minerals. Hydrogen and deuterium move around between hydroxide, water and other molecules, says **Sune Nielsen** of the Woods Hole Oceanographic Institution in Massachusetts. But unless Earth has lost a lot of hydrogen to space, which he says doesn't seem likely, the overall ratio of deuterium to hydrogen on the planet shouldn't change much.

Secrets of a supervolcano

Earthquake vibrations have revealed a second magma chamber lurking under Yellowstone National Park. This discovery helps explain why the park's supervolcano expels massive amounts of carbon dioxide each day, ***Thomas Sumner*** *reported in "Giant magma pool beneath Yellowstone"* (SN: 5/16/15, p. 16)*.*

"So the deeper chamber is like fudge — mostly solids and crystals, a little liquid running around in the interstices. The top chamber is like fudge sauce — mostly melted with some solids," commented **John Turner**. "Back when this hot spot was powering the Columbia Group basalt eruptions in Oregon, there were weeklong lava eruptions that roughly equaled the volume of Lake Erie, banging straight up out of mile-long cracks in the Earth with zero advance notice. We should be glad the dear thing has settled down a bit."

Where science and sci-fi meet

In "Cancerous clams and other sci-fi fodder" (SN: 5/16/15, p. 2)*, editor in chief* ***Eva Emerson*** *professed a love of science fiction. She noted that some current real-life research could stimulate the imagination just as well as any novel or movie.*

"Eva Emerson's editorial made me smile," said former physicist and full-time writer **Steve Moore** in an e-mail. "I cut my reading teeth on sci-fi. More importantly perhaps, I often use *SN* for background material in my sci-fi, giving credit at the back of the book. As scientists-turned-writers, we're often too specialized and need to refer to good, coherent summaries about new science and technology happening outside our chosen fields."

Correction

In "Food fight" (*SN: 5/30/15, p. 18*), the bile produced by the liver should have been described as a digestive fluid, not an enzyme.

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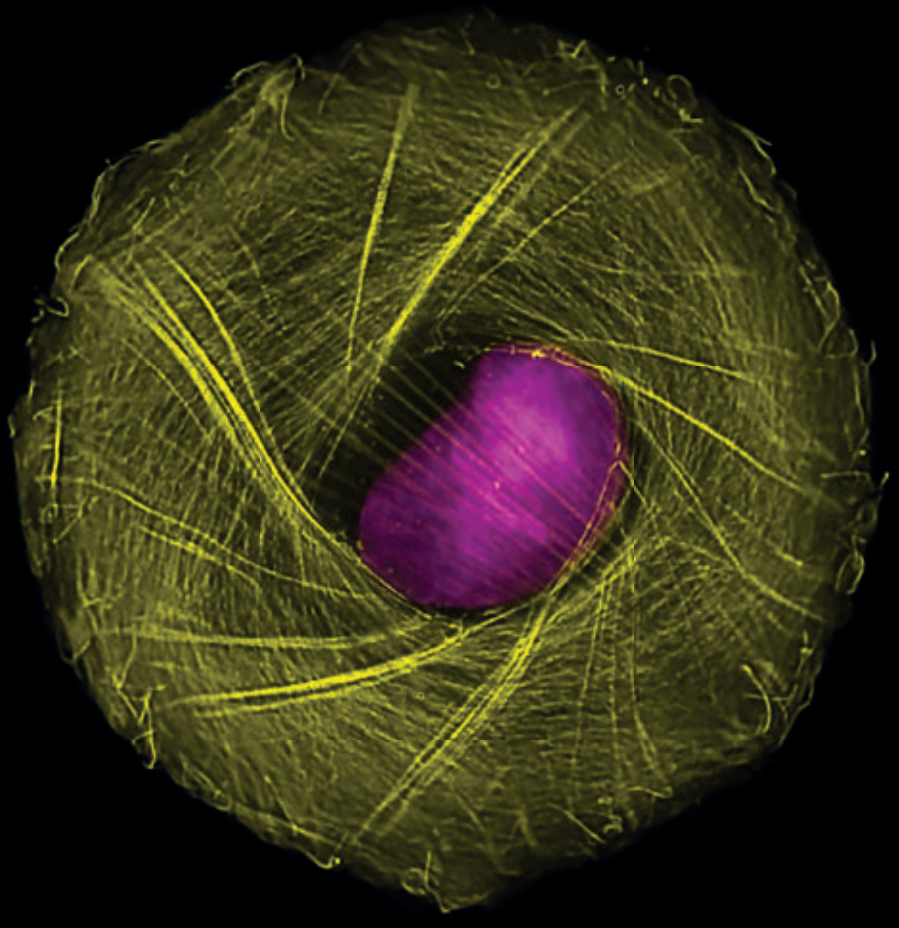
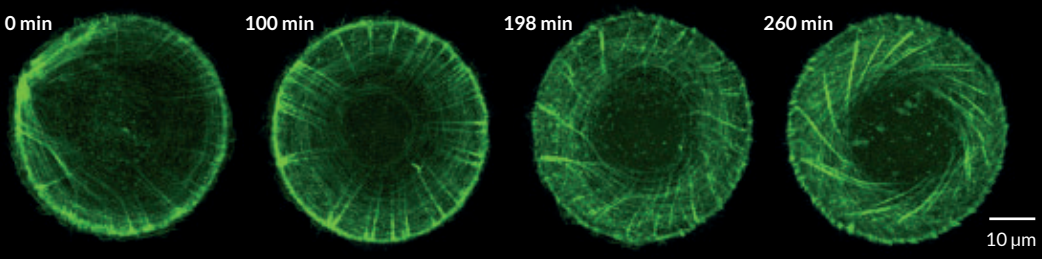
Twisty chains of proteins keep cells oriented

Fibers composed of a protein called actin are responsible for human cells' ability to tell right from left, researchers report in the April *Nature Cell Biology*. These twisty fibers (below, in yellow; cell's nucleus in magenta) are part of a cell's internal scaffolding known as the cytoskeleton. Among other functions, the fibers help cells migrate from one part of a developing embryo to another.

Scientists, including cell biologist Alexander Bershadsky at the National University of Singapore, had amassed evidence that the cytoskeleton enabled cells to distinguish right from left. So Bershadsky's colleague Yee Han Tee recorded 100 videos of actin fibers organizing themselves inside human foreskin cells placed under the microscope.

The researchers discovered that actin has a natural asymmetry that leads fibers extending from the cell's edge to twist counterclockwise (see bottom images). This preferred orientation influences navigation and other activities of the entire cell, as if the direction of a screw's threads could determine how a whole machine works, Bershadsky says.
— *Tina Hesman Saey*





Doing the twist
Fibers of the protein actin (green) grow and bend over the course of more than four hours. The fibers begin at the cell's edge and then extend toward the center with a counterclockwise warp.

Y.H. TEE *ET AL*/*NATURE CELL BIOLOGY* 2015

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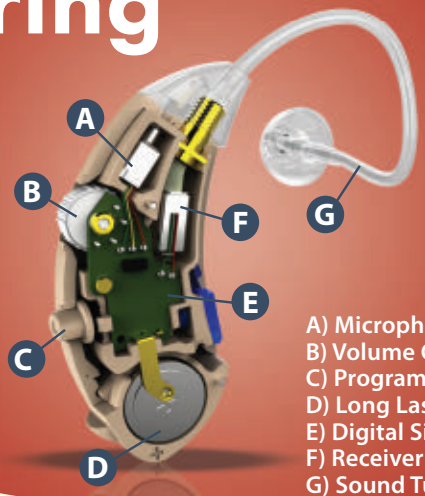

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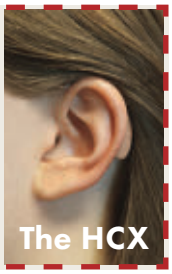
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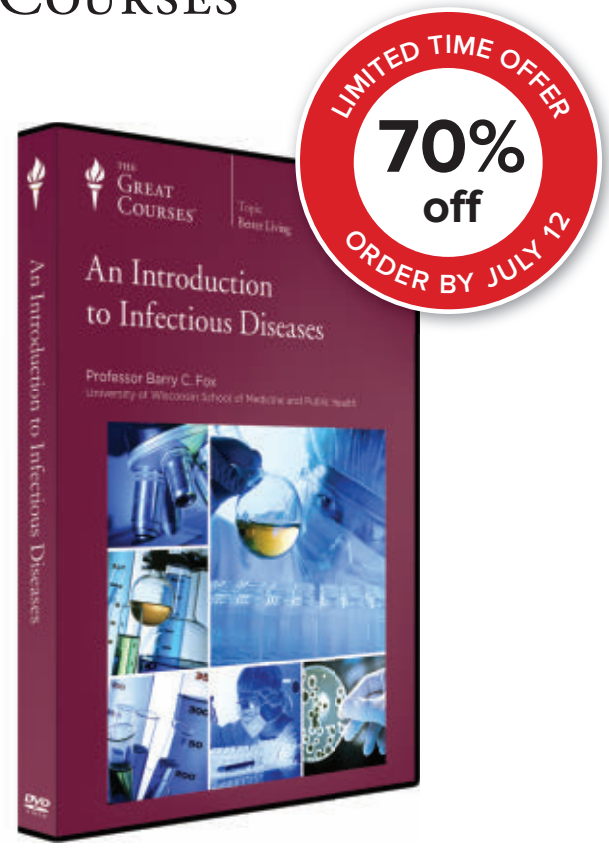

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