

Allies on the Reef | Puberty's New Normal | Lucy in the Trees

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ScienceNews

MAGAZINE OF THE SOCIETY FOR SCIENCE & THE PUBLIC ■ DECEMBER 1, 2012

Bright FUTURE

China sets its sights
on the stars

**Knockout Drugs
Tap Sleep Cells**

**Four-Winged Dinos
Take Their Turn**

**Humans Caused
Deadly Quake**

Found! The Last Morgan Silver Dollars

Nationwide Search Reveals Hidden Treasures

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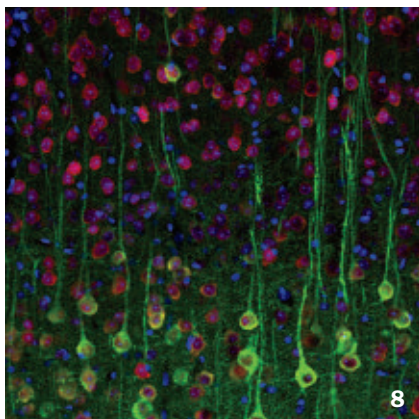
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FROM THE EDITOR

In change, remembering Science News traditions



I'm moving. It's only a distance of about 20 feet, but it looms larger in my mind. The editor in chief's office, which has sat empty since August, is now mine. Sorting through stuff left by my predecessors, I have found buried treasures: a bag of stringed beads, a wooden bookmark, yellowed reader survey responses, a

scribbled to-do item pinned behind a dusty cabinet ("Launch *Science News* on the Web"), and a copy of a 1950 *Science News* article titled "Hints for writing science."

I've seen this last item before, but rereading advice from two of the publication's early leaders still serves as a helpful reminder of the magazine's long, proud tradition. "Don't overestimate the reader's knowledge and don't underestimate the reader's intelligence," wrote Edwin Slosson, the first director of Science Service (now known as Society for Science & the Public). Watson Davis, director of Science Service when the article was published, adds his own list of "don'ts" for writers, expressing the aim of the organization as covering "the whole of science in the widest sense of the word." (Read the entire piece online at www.sciencenews.org/writingscience)

In that vein, this issue looks at a wide variety of questions posed by scientists of many different stripes. On Page 13, read about how emptying aquifers in Spain may have triggered a 2011 earthquake. Or, on Page 14, a description of how four wings might have enabled flying dinosaurs to dart through dense forests with agility. Other articles report on how anesthesia works by triggering brain cells involved in the onset of sleep (Page 8) and on a newly identified genetic mutation that explains why aspirin helps some people with colorectal cancer and not others (Page 18). And on Page 26, a longer story looks at a potentially worrisome trend: Puberty appears to be arriving earlier than it did in the past, especially in girls. Scientific tradition is explored on Page 20, with Nadia Drake's report from China about efforts there to reignite astronomical achievement. Stargazing has a long and storied past in China where, as early as 1700 B.C., scientists recorded supernovas. But it's a tradition interrupted by the Cultural Revolution. Now, the nation is making an all-out effort to catch up.

So that I don't lose sight of tradition, I've posted the old writing tips on my bulletin board, where they will serve as guideposts as we venture on into the future.

—Eva Emerson, Editor in Chief

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Say What?

Pingo \PIHN-goh\ *n.* A dirt-covered mound with an icy core. Pingos appear when underlying permafrost puts pressure on pooled groundwater, forcing it upward. The soil above the water bulges, creating a dome-shaped hill. Pingos might not be exclusive to Earth; Mars is dotted with pingolike mounds. An international team of researchers identified dozens of these geological bumps, some hundreds of meters wide, in satellite images of craters on Mars' Utopia Planitia. The mounds share similar dimensions and densities with Earth pingos, such as those found in northern Canada. The Red Planet's hills may have formed through Earthlike processes of freezing and thawing late in Mars' Amazonian epoch, the team concludes online September 19 in *Icarus*. —Allison Bohac



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ON THE SCENE BLOG

Geneticists poke a little fun at themselves during a recent meeting. Read “Buzzword bingo.”

SCIENCE & SOCIETY

Mapping U.S. votes for president according to state population gives a new view of politics. See “Red state, blue state.”

EARTH

Feedback loops are melting more ice than predicted, raising oceans faster. Learn more in “Sea level rise overflowing estimates.”



MATH TREK COLUMN

Theory shows why policy efforts fail in “Game theory suggests current climate negotiations won't avert catastrophe.”

Science Past | FROM THE ISSUE OF DECEMBER 1, 1962

NEW DATING METHOD FOR MILLION-YEAR-OLD FOSSILS — A new radioactive dating method promises to close one of the major remaining gaps in methods of fixing dates on the geological



and archaeological time scales. The new procedure, based on radioactive inequality in nature between uranium-234 and its parent U-238, was originated by David Turber of Columbia's Lamont Geological Observatory at Palisades, N.Y. The research is described in the *Journal of Geophysical Research*, Nov. 1962. Uranium-234

is an isotope of uranium formed by the radioactive decay of U-238. The “disequilibrium” between the two isotopes possibly can be employed to date sedimentary material — which often contains fossils — as old as 1 million to 1.5 million years.

Science Future

December 15

Activities, films and demonstrations reveal physics principles at the Exploratorium in San Francisco. See bit.ly/SFfullspec

December 17

Learn about super-massive black holes with astronomer Günther Hasinger at the American Museum of Natural History in New York City. See bit.ly/SFgunther

First | NORTH AMERICAN FEATHERED DINOS

The first feathery dinosaur fossils from the Americas have turned up in sandstone from an ancient riverbed in Alberta, Canada. Most other feathered dinos have come from China's Liaoning lake bed deposits. Previous fossils of the species, *Ornithomimus edmontonicus* (illustrated), hadn't revealed any feathers. Now, 75-million-year-old fossils of a yearling and adult show filaments, hypothesized as early stages in feather evolu-



tion. And a second adult sports a winglike array of feathers with a central shaft. The ground-dwelling plant-eaters probably didn't fly, glide or flap after prey. Instead, feathers may have created adults-only courtship displays, say Darla Zelenitsky of the University of Calgary and colleagues in the Oct. 26 *Science*. —Susan Milius

Science Stats | CLUELESS GEN X

Less than half of 5,100 U.S. adults surveyed from Generation X (born from the early 1960s through the early '80s) could identify the object in this picture as a galaxy.

SOURCE: GENERATION X REPORT, FALL 2012



Percentage able to correctly identify image



“ Despite what we tell our patients, anesthesia and sleep are not at all the same. ” — MAX KELZ, PAGE 8

Science & Society The borrowing game

Genes & Cells Origins of blood types

Earth Warm waters may melt methane

Life A new family tree for birds

Humans Lucy's peers were tree climbers

Atom & Cosmos DNA and dark matter

Health & Illness Smoking ban benefits

In the News

STORY ONE

Goby fish react to corals' cue by helping keep algae at bay

Defense pact shows how reefs adapt to invaders

By Susan Milius

When a killer seaweed touches a kind of spiky coral, the coral pushes a chemical panic button that brings small resident fish to the rescue.

Seaweed, or marine algae, left unchecked can overrun a coral reef, as the community dwindles in “a descent into slime,” says marine ecologist Mark Hay of the Georgia Institute of Technology in Atlanta. But within 15 minutes of contact with a toxin-making seaweed, an *Acropora nasuta* coral releases compounds that prompt goby fish to seek out and trim back the seaweed, Hay and colleague Danielle Dixon report in the Nov. 9 *Science*.

“We’ve lost about 80 percent of the living coral in the Caribbean and 50 percent in the western Pacific,” says coral biologist Nancy Knowlton of the Smithsonian Institution in Washington, D.C. “So a better understanding of what keeps corals healthy is essential.”

In reefs, corals compete for light and space with seaweeds that grow as lawns or shrubby thickets. As coral reefs decline from pollution, overfishing,



Living among branches of *Acropora nasuta* coral, a goby (*Gobiodon histrio*) reacts to a chemical cue that its sheltering coral releases if touched by green, toxic turtleweed (right). Gobies nip back the encroaching foliage, protecting the coral.

climate change and other insults, biologists have seen swaths of seaweed take over. Lush seaweed intrusions repel or smother larval corals, accelerating what Hay calls the reef “death spiral.”

In this scenario, corals dwindle and fish and other reef creatures find fewer safe nooks and crannies to live in. The reef then has fewer algae-eating fish, which means even less protection for the habitat-maker corals that maintain diverse life. “Without these,” Hay says, “you have these algae-covered parking lots.”

The discovery of *A. nasuta*’s on-demand guards came from thinking small. Hay and Dixon partially caged individual colonies of *A. nasuta*, which branch “like a tightly compacted deer’s antlers,” Hay says. For each coral, researchers either removed or left alone some of the creatures that lurk in the coral’s crannies. Then the team tested reactions to the emerald-green turtleweed *Chlorodesmis fastigiata*, one of the reef invaders most toxic to corals.

“It’s a really pretty and really nasty



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little plant,” Hay says. If left unchecked, fronds that grow against coral secrete chemical weapons that start killing coral tissue within two days of contact.

When researchers fastened toxic seaweed strands to dangle against the corals, two kinds of damselfishes were no help at all, abandoning the troubled sites within 48 hours. Two species of the small colorful gobies that settle into corals, however, “were like little hedge trimmers,” Hay says.

Both the broad-barred goby (*Gobiodon histrio*) and the redhead goby (*Paragobiodon echinocephalus*) chewed back seaweed until it no longer brushed against their home coral. The trigger was a substance produced by the coral itself, the researchers found. In experiments, gobies ignored seaweedlike tufts of string brushing their corals, unless the string had been treated with extracts from the seaweed. Overall, corals caged with their vigilant gobies suffered only about a quarter of the damage inflicted by seaweed on corals without a goby squad.

Patrolling for toxic seaweed may boost one of the fish species’ own defenses against predators, the researchers suggest. Biologists have known that *G. histrio* skin secretes some kind of toxin, which leaves several kinds of goby-eating fishes struggling to swim upright. After coming



A coral with its resident fish fenced out (left) sustained damage (white tips) under a patch of toxic turtleweed. With goby fish present (right), the algae are pruned and the coral looks almost normal. White string served as a control for comparison.

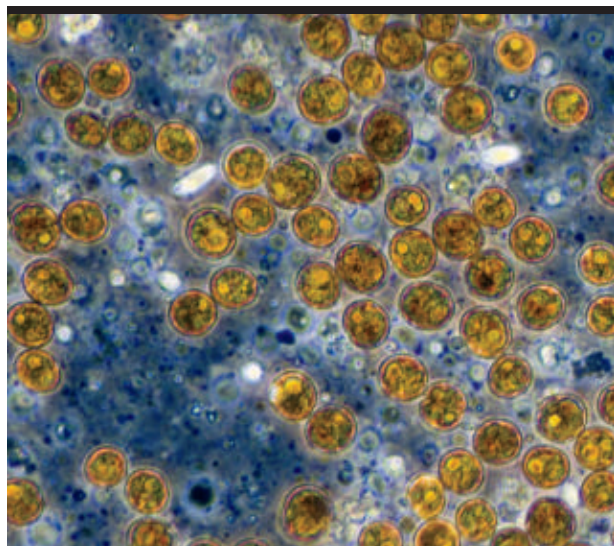
to the aid of a seaweed-threatened coral, a *G. histrio* goby carried particularly strong skin mucus that knocked predators for a loop more than twice as fast.

This previously overlooked defense partnership shows just how little biologists know about the complex food webs of coral reefs, says marine ecologist John Valentine of Dauphin Island Sea Lab in Alabama. The gobies remind him of small crabs that hide in certain corals and nip the tube feet of encroaching crown of thorns starfish that can ravage a reef.

Just how the goby alert cue works remains to be seen, but Hay notes that *G. histrio* gobies swallowed seaweed when they trimmed it. The other goby species, which doesn’t have toxic skin,

mowed but didn’t swallow the algae. “Typically we think of large fish controlling algae for the benefit of corals,” says ecologist Douglas McCauley of Princeton University. The gobies are much smaller than the usual coral defenders that reef conservationists have been thinking about.

Reefs need diverse defenders, Hay says. Big grazing fishes like parrotfish and surgeonfish have different tastes in seaweed. And a kind of rabbitfish is one of the few species, besides the gobies, that will not just ignore the chemically defended *Chlorodesmis* seaweed tufts. “It stops and shakes, as if it’s just so excited,” Hay says. Then the rabbitfish crops the killer seaweed down to scuzz. ■



Back Story | HELPFUL ALGAE

Although turtleweed algae is a beautiful killer of coral, many algae serve essential functions in reef ecosystems. Most corals can’t survive without live-in help from various kinds of single-celled *Symbiodinium* algae (shown). These algae shelter inside coral tissue, where they capture energy from sunlight and share the resulting sugars and other essential products with their coral landlords. Among bigger algal species, tough cement makers called crustose calcareous algae help hold a reef together and create ridges that withstand pounding waves. Some of these calcareous crusts, such as *Titanoderma prototypum*, attract coral larvae searching for a home. Small filamentous algae power the base of the food web by serving as underwater meadows that nourish grazing animals. Other algae, largely inedible, such as *Halimeda* species, offer hiding places for youngsters dodging predators. In some senses, a coral reef is an algal reef too. —Susan Milius

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Mind & Brain

“It’s hard to have designer drugs without knowing what they’re designed to do.” —HUGH HEMMINGS JR.

Anesthesia hits sleep neurons

Results might lead to improved knockout drugs

By Laura Sanders

Anesthesiologists aren’t totally lying when they say they’re going to put you to sleep. Some anesthetics directly tap into sleep-promoting neurons in the brain, a study in mice reveals.

The results may help clarify how drugs that have been used around the world for decades actually put someone under (*SN*: 5/21/11, p. 18). “It’s kind of shocking that after 170 years, we still don’t understand why they work,” says study coauthor Max Kelz of the University of Pennsylvania.

Anesthetics appear to calm most brain neurons, says neuropharmacologist and anesthesiologist Hugh Hemmings Jr. of Weill Cornell Medical College in New York City. But the new results, published November 6 in *Current Biology*, show that two common anesthetics stimulate sleep-inducing neurons.

In the study, Kelz and colleagues studied the effects of the anesthetics isoflurane and halothane. Mice given the drugs soon became sleepy, as expected. Along with this drowsiness came a jump in nerve cell activity in a part of the brain’s hypothalamus called the ventrolateral preoptic nucleus, or VLPO.

Not all neurons in the VLPO are the same. Some are involved in initiating sleep, while neighboring neurons don’t seem to play a role. The anesthetics affected only the VLPO neurons that promote sleep, the team found. When the scientists destroyed VLPO neurons, the mice were less sensitive to the effects of isoflurane. These animals needed higher doses of the drug to make them groggy, suggesting that this brain spot is important for anesthetic effects.

The drugs in the study aren’t commonly used in the United States but are similar to anesthetics that are. There’s some evidence that propofol, the anesthetic that Michael Jackson co-opted as a sleep aid, may activate the same population of sleep-inducing neurons, says Kelz.

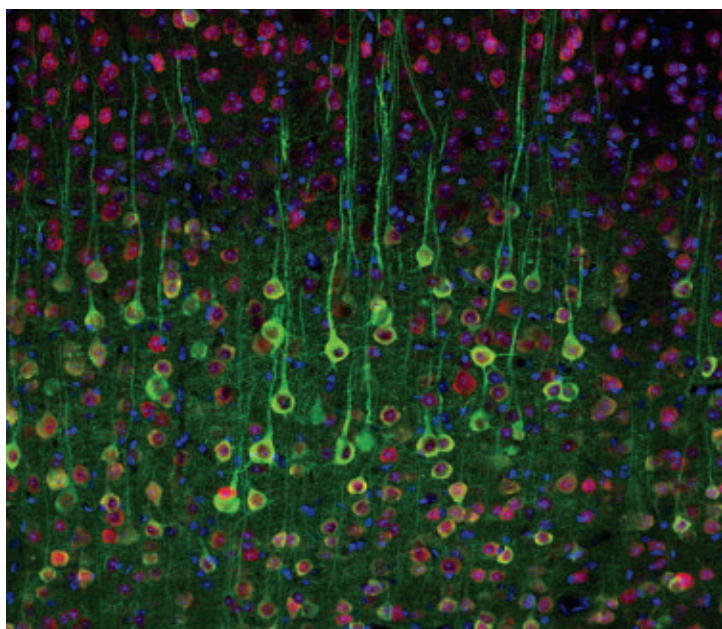
Further experiments revealed that isoflurane works by changing how these VLPO neurons respond to potassium atoms, though exactly how that happens isn’t clear.

Even after finding this direct link between natural sleep and being under anesthesia, Kelz says that the two situations are different. “Despite what we tell our patients, anesthesia and sleep are not at all the same,” he says.

But understanding how the brain turns off may lead to a clearer view of some of the deepest mysteries about the brain, such as how it turns on and generates consciousness.

And the finding could help scientists design better anesthetics. “The drugs that we have are fraught with side effects that we’d like to eliminate or avoid,” Hemmings says. Studies like this one, which clarify how the brain responds to anesthesia, will point out which brain changes are important and which are side effects, he says. “It’s hard to have designer drugs without knowing what they’re designed to do.” ■

The finding could help scientists design better anesthetics.



An enlightened idea

A genetic tweak makes it easier to see neurons at work in living, breathing animals. The method, described in the Oct. 18 *Neuron*, capitalizes on a property of a busy neuron: When the cell fires, calcium ions flood in. Genetic changes to the protein GFP make the protein light up when calcium is present. Like a beacon, the glowing protein (seen in green in these neurons with pink centers) tells scientists which neurons are active. Guoping Feng, a neuroscientist at MIT, and colleagues used the protein in mice to see smell-sensing neurons respond to an odor and movement neurons light up during walking. The team also saw neurons glow when a puff of air moved a whisker. In the future, the technique could offer a clearer view of more complex brain jobs, such as memory, problem-solving and social interactions—experiments that could reveal how nerve cells misbehave in conditions such as autism.

—Laura Sanders

QIAN CHEN

Capturing dark matter with DNA

Physicists propose biobased detector for elusive particles

By Tanya Lewis

RALEIGH, N.C. — Physicists racing to detect the mysterious substance known as dark matter are thinking outside the box by looking inside the cell. A new proposal for tracking dark matter particles relies on strands of DNA.

All the ordinary stuff in the universe, from the atoms in people to the hot plasma in stars, makes up only about 5 percent of the universe's mass and energy. Nearly one-quarter of the universe is composed of dark matter. (The rest is an even more puzzling entity known as dark energy.) Though several experiments claim to have detected dark matter, the results don't agree and aren't definitive.

Katherine Freese, a theoretical physicist at the University of Michigan in Ann Arbor, proposed October 28 at the New Horizons in Science meeting that a new kind of DNA-based detector could not only spot a leading candidate for dark matter particles, but could also determine the incoming particles' direction of flight. The proposal also appeared online earlier this year at arXiv.org.

"It's a very smart way to apply technology developed from biology to a fundamental particle physics problem," says Jocelyn Monroe, a dark matter physicist at MIT and the Royal Holloway University of London.

A halo of WIMPs — weakly interacting massive particles — is thought to encircle the Milky Way. As the sun orbits the galaxy's center, it should encounter a "wind" of WIMPs from the direction of the constellation Cygnus. At any point on Earth, such a wind should strengthen and weaken seasonally as the Earth moves toward or away

from the wind, as well as daily as the planet rotates.

Freese and her colleagues' proposed detector, which would be sensitive to these fluctuations, consists of a stack of thin gold sheets with single-stranded pieces of DNA hanging from them. When a WIMP smacks into the nucleus of a gold atom, the nucleus would recoil through hundreds of DNA strands, cutting the ones it hits in precise locations.

Scientists would then collect and sequence the DNA to reconstruct the path traveled by the nucleus and, by extrapolation, that of the WIMP. If the detector spotted the daily fluctuation and the particles' paths proved

consistent with the WIMP wind's direction, it could be compelling evidence that the signals came from dark matter.

"The advantage of these detectors is that the difference between DNA bases is a nanometer," says Freese, "so it's much better resolution" — about 1,000 times better than current detectors.

The device could also be smaller and cheaper than existing detectors.

Still, the technique has yet to be demonstrated, says Joel Schnur, a biomolecular scientist at George Mason University in Fairfax, Va. "What is the real sensitivity to cleavage of DNA?" he asks. "How many particles will come down over time? And can it detect them?" ■



Digging deep into Martian soil

NASA's Curiosity rover isn't leaving just tire tracks in the reddish Martian dust—it's also leaving scoop marks (above) in an area called Rocknest, about 480 meters away from where the rover touched down in August. On October 30, NASA announced that the rover had completed its first detailed analysis of the Martian surface using the CheMin X-ray analysis instrument, which shoots X-rays into collected samples. The results suggest that the Rocknest soil is rich in minerals such as olivine, feldspar and pyroxene, much like patches of weathered volcanic soil in Hawaii. — *Nadia Drake*

Genes & Cells



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Blood types have deep roots

ABO system may date back 20 million years or more

By Rachel Ehrenberg

Chimps, gibbons and other primates are not just humans' evolutionary cousins; a new analysis suggests they are also blood brothers. Blood types found in people today evolved at least 20 million years ago in a common ancestor of humans and other primates, new research suggests.

The analysis deepens a mystery surrounding the evolutionary history of the ABO blood system, and should prompt further research into why the different blood groups have persisted over time, Laure Séguérel of the University of Chicago and colleagues report November 6 in the *Proceedings of the National Academy of Sciences*.

"Their evidence is rather convincing that this is a shared, very old capability that has remained throughout the divergence of the species," says physician and transfusion specialist Martin Olsson of Lund University in Sweden.

Different forms of a single blood type gene determine what kinds of molecules sit on your red blood cells: type A molecules, type B molecules, A and B together, or no intact surface molecules in the case of type O.

The A, B and O versions of the gene differ only slightly, and scientists have debated two scenarios to explain their evolution. One posits that the A version of the gene existed long ago, and the B and/or O versions later cropped up independently in several species (including humans, gorillas, baboons and chimps). Alternatively, all of those species may have inherited the A and B types from a single ancestor.

Researchers led by Séguérel looked at a particular stretch of DNA in the blood type gene in humans, bonobos, chimpanzees, gorillas, orangutans, gibbons and several species of monkey. Then the scientists compared that stretch of DNA across species on the primate family tree. The pattern they saw suggests that the A and B blood groups were around at least 20

million years ago, probably as far back as the common ancestor of humans and Old World monkeys.


Exactly why evolution would favor a mix of blood types in so many species is a mystery. Depending on blood type, people are more or less susceptible to particular pathogens. Type O people, for example, are more susceptible to cholera and plague, while people with type A are more susceptible to smallpox. Blood

group diversity may have been maintained for so long because each version was immunologically advantageous in certain times and places.

"That diversity may have led to protection against whatever might come your way," says glycoimmunologist Brian Cobb of Case Western Reserve University in Cleveland.

"Their evidence is rather convincing that this is a shared, very old capability that has remained throughout the divergence of the species."

MARTIN OLSSON

People with type A are also more prone to blood clots, Olsson says. When humans and their ancestors were having babies in caves and fighting predators without the option of an emergency room, such clotting may have been beneficial. 

Fasting hormone boosts longevity

Life span benefits in mice mimic those in caloric restriction

By Tina Hesman Saey

A hormone that makes the body think it's starving could prolong life about as long as severely cutting calories does, but without the denial.


Fibroblast growth factor-21, or FGF21, lengthened the lives of mice genetically engineered to constantly produce large amounts of it, researchers report online October 15 in *eLife*. The hormone is normally made by the liver during fasting and may tap into the same life-extending biochemical processes as restricting

calories, a proven longevity booster in some animals.

Caloric restriction — usually defined as cutting calorie intake to 75 to 80 percent of the amount needed to maintain normal body weight while still maintaining good nutrition — has been shown to lengthen life in a wide variety of species. Minimal calorie consumption turns on many biological processes that slow aging, says Cynthia Kenyon, a developmental biologist at the University of California, San Francisco. The hormone in the study somehow interferes with a chain reac-

tion anchored by insulin-like growth factor-1, a process also shut down by caloric restriction and thought to be responsible for many of its life-extending effects.

Researchers led by David Mangelsdorf and Steven Kliewer, both of the University of Texas Southwestern Medical Center, genetically engineered mice to make five to 10 times as much FGF21 as normal. These mice lived 30 to 40 percent longer than normal mice on a standard diet.

But the news was not all good. Higher levels of FGF21 were associated with low bone density and female infertility. Both drawbacks are part of the body's normal response to starvation and could pose problems if the hormone were used to treat people, Mangelsdorf says. 

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Gulf Stream may melt methane

Warm waters threaten to release gas from seabed

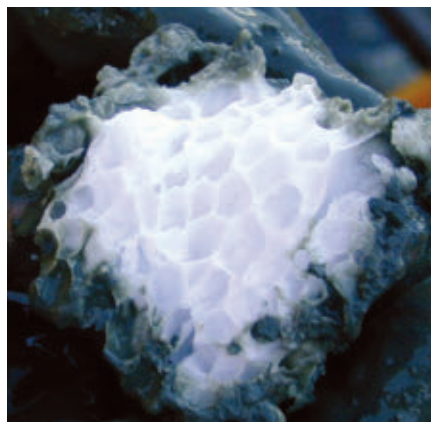
By Tanya Lewis

While it's no ice-nine, a frozen form of methane trapped in ocean sediments could be cause for concern. Warm Gulf Stream waters off the east coast of North America are converting large amounts of the substance into methane gas, which could lead to underwater landslides and influence global climate.

A good portion of the carbon on Earth is stored in the seafloor as methane hydrate, a frozen mixture of methane and water formed at high pressure and low temperature. Changes in the temperature or direction of the Gulf Stream, which carries warm water north from the Gulf of Mexico, have heated sediments in a strip along the North Atlantic seafloor by 8 degrees Celsius. This warming is unlocking 2.5 billion metric tons of methane from deep-sea caches, scientists report in the Oct. 25 *Nature*.

This is the first study to suggest that methane hydrate melting is related to ocean currents themselves, says coauthor Benjamin Phrampus, an earth scientist at Southern Methodist University in Dallas. Previous studies suggested that ocean temperatures would have to increase globally to cause hydrate breakdown, which would take a huge input of energy, he says. "We don't need this large amount of energy to explain this. It's simply a change in the ocean currents."

In Kurt Vonnegut's 1963 novel *Cat's Cradle*, the fictional substance ice-nine crystallizes all liquid water it touches, with the power to wipe out all life on Earth in an instant. The conversion of methane hydrate to gas isn't nearly so apocalyptic, though. While methane is a much more potent greenhouse gas



Methane hydrates (one shown above) trap methane in a frozen mix in the seafloor. Warm ocean currents are heating them up and releasing methane in an area off the coast of North Carolina (right).



than carbon dioxide, at the depths it's being released most will never reach the atmosphere. Instead, it will dissolve in seawater, where microbes will guzzle it up and convert it to carbon dioxide. Even if methane does reach the surface, its lifetime in the air is only about a decade.

To affect global warming, "you'd have to add quite a bit of methane to the atmosphere to really move the needle much," says geophysicist Carolyn Ruppel of the U.S. Geological Survey in Woods Hole, Mass. Where it becomes a problem, Ruppel says, is if sediments retain the methane gas, which could make underwater slopes much more prone to landslides. These slides might release even more methane from the seabed or trigger tsunamis.

Unstable hydrates may have caused past slides in this region of the North Atlantic, and similar ones could release an order of magnitude more gas than what's already escaping.

Sudden methane hydrate release has been proposed as the cause of global warming events like the Paleocene-Eocene Thermal Maximum, a rapid spike in global temperature of more than 5 degrees that occurred about

55 million years ago. Compared with the PETM, the amount of gas being released by hydrates off the U.S. East Coast is very small, Phrampus says, but he notes that "it's very unlikely that this is the only part of the world where it's occurring."

The study relied on indirect measurements of seafloor temperature to infer that hydrates are disintegrating. These methane solids can exist only in the top few hundred meters of ocean sediments. Below that, Earth's warm interior keeps methane a gas. Seismic signals revealed the depth where solid hydrates met gassy methane. Comparing this depth with theoretical predictions suggested that the region was probably cooler in the past, but changes in the Gulf Stream within the last 5,000 years are causing it to heat up.

Methane hydrates will be breaking down over the next few centuries if the Gulf Stream doesn't cool off or shift its position. Because scientists don't know how much methane hydrate is out there or how much gas could be released, however, the impact on global climate remains unclear.

"I think we really have to keep an open mind on this right now," says Gerald Dickens of Rice University.

LEFT: WUSELOO7/WIKIMEDIA COMMONS; RIGHT: DATA: SIO, NOAA, U.S. NAVY, NGA, GEBCO, © 2012 CNES/SPOT IMAGE; IMAGE: U.S. GEOLOGICAL SURVEY © 2012 TERRAMETRICS; GOOGLE EARTH

“Even without the groundwater extraction, the earthquake was overdue.” —PABLO GONZÁLEZ

Wells linked to Spanish earthquake

Draining aquifers probably triggered deadly 2011 tremor

By Alexandra Witze

Farmers and other residents pumping groundwater from Earth's crust probably triggered an earthquake that killed nine people last year in southeastern Spain, scientists have found.

Sucking up water for decades would have unloaded stresses within the ground and hastened a quake that was likely to happen anyway, says Pablo González, a geologist at the University of Western Ontario in London, Canada.

“Even without the groundwater extraction, the earthquake was overdue,” he says. But human activities provided “a kind of triggering or controlling.”

González and his colleagues report the discovery online October 21 in *Nature Geoscience*.

Scientists know that people can change the rate of earthquakes by piling up water within the crust, such as behind a dam. Some researchers argue — though it is not entirely accepted — that filling a nearby reservoir may have set off the magnitude 7.9 quake that killed some 80,000 people in Sichuan, China, in 2008. Injecting water into the crust, such as during hydraulic fracturing or other drilling, can also trigger quakes; geothermal drilling operations in Basel, Switzerland, set off a small earthquake there in 2006.

Overall, these triggered tremors are usually quite small, on the order of magnitude 3. The quake that struck Lorca, Spain, on May 11, 2011, was magnitude 5.1. But that isn't uncommon for that region of Spain, the most seismically active part of the country, González says.

Lorca is also a place where lots of underground water gets pumped up for farming and drinking. As a result, the land surface is subsiding at about 10 centimeters each year, the highest rate known in Europe.

After the quake hit, González and his

colleagues decided to see whether there was any connection. They used satellite radar data to determine how the ground shifted before and after the quake, and then developed a mechanical model to explain what kind of ground stresses would cause that movement.

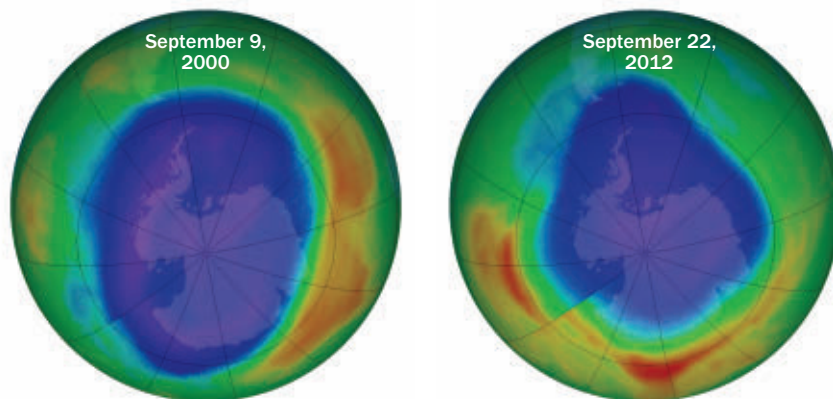
The quake struck at surprisingly shallow depths, just 2 to 4 kilometers down, the scientists found. The ground's movement almost precisely matched the areas where stress had changed the most within Earth's crust because of groundwater pumping, the team calculated. Both findings suggest that draining the aquifers pushed the crust over some threshold and accelerated the quake, González says.

Stress changes caused by groundwater extraction are tiny compared with the

usual stress brought about by tectonic forces. That's why it would have been hard to predict the Lorca quake based just on groundwater use, González says. And the findings probably don't apply to other quake-prone areas where groundwater is also being pumped. “If the fault is not located right on the border of the aquifers where you have the changes in water level, it would probably not have much effect,” he says.

The new study is the first to show how a change in stresses within the crust caused by removing water can trigger earthquakes. That finding underscores how little scientists still know about the effects of altering the crust, writes Caltech geologist Jean-Philippe Avouac in a commentary accompanying the study.

“We know how to start earthquakes, but we are still far from being able to keep them under control,” Avouac writes. ■



Ozone hole hits smallest maximum

The seasonal hole in the ozone layer above Antarctica has reached its smallest maximum extent and second lowest average area in 20 years thanks to warm air temperatures. Each September the ozone layer, which shields Earth from the sun's ultraviolet radiation, thins over the South Pole. The largest ozone hole on record occurred in 2000 (left, shown in blue and purple), measuring 29.9 million square kilometers. On September 22 (right) of this year, the hole grew to this season's maximum: 21.2 million square kilometers, an area slightly smaller than North America. That's the smallest the ozone hole has been at its annual maximum since 1990. The average size of the 2012 ozone hole was 17.9 million square kilometers, the smallest average since 2002. Frigid temperatures help promote the destruction of the ozone layer. But normal weather fluctuations led to warmer Antarctic temperatures this year, limiting the damage, scientists say. —Erin Wayman

Life

Four-winged dino made tight turns

Much-debated rear wings aided aerial maneuvers

By Susan Milius

The hind wings of four-winged dinosaurs probably stayed tucked under the body until deployed in the air for tight turns to dodge branches or chase prey, new work suggests.

Just what a dinosaur did with well-developed feathers on all four of its limbs has been a puzzle since 2003, when paleontologists unveiled roughly 130-million-year-old *Microraptor gui* fossils from northeastern China. The first reconstruction showed the small dinosaur gliding in the air with all four limbs extended outward. A later proposal lowered the hind-limb feathers for a biplane-like arrangement.

In a simpler solution, the dinosaur could have kept its hind limbs under

its body much of the time until needed for banking in a turn, Justin Hall of the University of Southern California said October 20. Extending a feathery right leg a bit while veering left, or vice versa, could easily have upped the dino's speed and shrunk the radius of a turn, he and his colleagues calculated.

Boosting agility makes more sense aerodynamically than keeping both hind limbs extended, Hall said. The probable shape of the hind legs' feather array wouldn't have generated much lift, so the extra surface would have been worse than useless for straight-ahead moves. "For every surface, you pay a little drag tax," said coauthor Michael Habib, also at USC.


In contrast, deft maneuvering would have helped the forest-dwelling *M. gui* cope with complex obstacles. The four-winged dinosaur still had the basic body shape of its terrestrial lineage, and feathery legs and a large tail fan could have

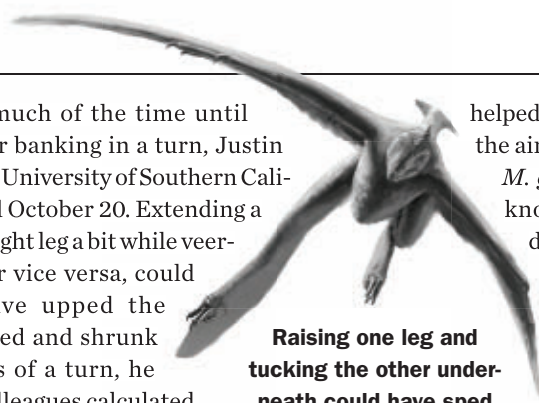
Raising one leg and tucking the other underneath could have sped up aerial movements in four-winged dinosaurs, such as this turn in an artist's illustration of *Microraptor gui*.

helped compensate when in the air.

M. gui may be the best-known of four-winged dinosaurs, but paleontologists have since found several more. The newly described method of calculating an agility boost should work for all four-winged species, said coauthor Luis Chiappe of the Natural History Museum

of Los Angeles County. Agility should matter regardless of whether a four-winged dinosaur could power along in sustained flight or just glide, Habib added.

The idea that *M. gui* extended all four wings doesn't make sense, agreed Kevin Padian of the University of California, Berkeley. But he warned that reconstructions of flight evolution should separate gliding from powered flapping because they end up in different lineages. 



Earliest primate gets ankle bones

A creature known from fossil teeth acquires more parts

By Susan Milius

Finally, the earliest known primate has more than a mouth. Several 65-million-year-old fossil ankle bones from Montana belong to a small tree-dwelling species known as *Purgatorius*, Stephen Chester of Yale University announced on October 19.

The first signs that *Purgatorius* existed came from fossil teeth unearthed nearly half a century ago in northeastern Montana, not far from where the first *Tyrannosaurus rex* was unearthed. Paleontologists named two species, and since then William Clemens of the University of California Museum of Paleontology, a coauthor on the new study, has


described more teeth and some bits of mouth bones.

But nothing had turned up from the rest of the body. "The teeth were so primitive, we didn't know much," said Ken Rose of Johns Hopkins University School of Medicine in Baltimore. Sorting out the relationships among early primates has been tricky.

On the off chance that some *Purgatorius* bit had been overlooked, Chester and Jonathan Bloch of the Florida Museum of Natural History looked through the trove of Clemens' fossils that had yet to be classified. After about two days of looking, they found an ankle bone. It looked much like other known primate fossils, and the researchers immediately

thought of *Purgatorius*. "You know a Picasso when you see one," Bloch said.

No other animal known from the excavation could have had an ankle like that first find or several other specimens, Chester said. Size calculations also put the creature in the same range as the size predicted by the tooth analysis. The shape of part of the ankle indicates that the animal would have moved easily in many directions — perfect for scampering through the complex angles and knobs of trees.

The identification convinced Daniel Gebo, an anthropologist at Northern Illinois University in DeKalb. The ankle bones link in "a type of slam dunk" to very ancient primate-like creatures called plesiadapiforms, he says. They didn't have all the traits of primates known today, though, so he doesn't call *Purgatorius* a true primate. 

Bird family tree alters avian history

Unexpected pattern of evolution found across hemispheres

By Susan Milius

The most ambitious effort yet to trace the evolutionary history and geography of living birds is ruffling the feathers of some old ideas.

For the first time, a new avian family tree places each of the 9,993 known species of living birds on its own twig. Western Hemisphere birds seem to have diversified faster than Eastern Hemisphere ones, Walter Jetz of Yale University and his colleagues report online October 31 in *Nature*.

Bird species abound in the East. No single lineage drives this hemispheric pattern. Instead, it comes from scattered bursts of rapid species evolution on a variety of branches.

Some patterns in the tree were expected, but other findings are "surprising and challenging," says Robert Ricklefs of the University of Missouri–St. Louis.


The hemispheric trend brings a new twist to an old discussion about species formation rates, which often focuses on comparisons across latitude. About three-quarters of modern bird species live in the tropics, and some biologists have argued that such feathered splendor comes from new species forming quickly there and outpacing tropical extinctions. According to some influential earlier studies, species formation dwindles as latitude increases.

The big new tree found no overall relationship with latitude gradient, Jetz

says. This observation supports a long-standing alternative idea for explaining tropical diversity: "Perhaps birds simply have had more time there," he says.

Birds such as white-eyes are already famous for diversifying quickly, but Jetz and his colleagues also found fast diversification among ducks, woodpeckers and some groups of gulls.

The researchers spent five years tracing the deep history of birds. For more than 6,000 of the species, the team used genetic data to determine each bird's near relatives. The scientists then placed the rest of the species in the tree by finding a species traditionally considered a relative for which genetic data were available.

But placing a third of the species without help from DNA data and without knowing about real extinctions in the lineage could have distorted the results, says Jason Weir of the University of Toronto Scarborough. 

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Fossil puts Lucy's kind up a tree

Contested analysis of shoulder portrays hominid as climber

By Bruce Bower

The ancient hominid known as Lucy is getting shouldered into the trees by a fossil child. But scientific onlookers disagree about whether Lucy's long-extinct species mixed tree climbing with walking.

Apelike shoulder blades from the ancient skeleton of a roughly 3-year-old girl that belonged to *Australopithecus afarensis* suggest that these early members of the human evolutionary family split time between scrambling up trees and walking on the ground, say paleobiologist David Green of Northwestern University in Downers Grove, Ill., and anthropologist Zeresenay Alemseged of the California Academy of Sciences in San Francisco.

Scientists have argued for more than 30 years about whether *A. afarensis* — the species defined by Lucy, a famous 3.2-million-year-old partial female skeleton found in 1974 — was built mainly for walking or possessed physical attributes suitable for ascending trees as well. Shoulder blades of the fossil child discovered in 2000 in Dikika, Ethiopia, indicate that Lucy's crew could indeed scale trees beginning early in life, Green and Alemseged report in the Oct. 26 *Science*.

A. afarensis lived in East Africa 3 million to 4 million years ago. Lucy and her cohorts spent plenty of time on foot but climbed trees to forage for fruit and to escape

predators, Green proposes. Based on the new analysis of the Dikika fossils, he says, "juvenile members of *A. afarensis* may have been more active climbers than adults."

A previous analysis of the Dikika child, dubbed Selam by its discoverers, suggested that the youngster's shoulder blades — partly encased in rock at the time — resembled those of gorillas. Green and Alemseged have since freed the fossils from the surrounding rock. Comparisons with other hominid fossils, modern apes and humans suggest that Selam's shoulder blades are generally apelike enough to have enabled regular tree climbing.

As in living apes, Selam and Lucy had upward-pointing shoulder sockets, Green and Alemseged say. People are born with slightly downward-pointing shoulder sockets that eventually shift to face laterally.

A bony ridge on the back of Selam's shoulder blades runs diagonally, as in living apes, the researchers add. The same ridge runs horizontally across the top of people's shoulder blades.

Selam's apelike shoulders represent an evolved accommodation in *A. afarensis* for mixing walking with climbing, writes anthropologist Susan Larson of Stony Brook University in New York in the same issue of *Science*.

But Green and Alemseged need to conduct a more detailed analysis

of various bony landmarks on Selam's shoulder blades to support a scenario of

frequent tree climbing, says anthropologist Yohannes Haile-Selassie of the Cleveland Museum of Natural History.



A youngster's fossil skeleton, which includes a skull (shown) and shoulder blade, may indicate that the early hominid *Australopithecus afarensis* mixed tree climbing with walking.

Haile-Selassie led a team that discovered a 3.6-million-year-old partial male *A. afarensis* skeleton known as Big Man. Everything about that find, including its legs, chest and a shoulder blade, point to a nearly humanlike gait for Lucy's species, he says.

If Green and Alemseged show in future work that the Dikika child's leg and foot worked in concert with her shoulder to promote climbing, Haile-Selassie says, "then they may very well have a species different from *A. afarensis*."

Skeletal traits, such as the shoulder socket's orientation, can pass from an ancestral species to a descendant species because they're crucial for survival or as functionally irrelevant hangers-on, says anthropologist Carol Ward of the University of Missouri in Columbia. "This makes the significance of the Dikika shoulder blades difficult to interpret."

A. afarensis probably retained some shoulder characteristics of earlier tree-climbing hominids that had no impact on what had become a ground-based lifestyle, says anthropologist Owen Lovejoy of Kent State University in Ohio, who participated in the investigation of Big Man's remains. ■

The fossil shoulder blade of a 3.3-million-year-old hominid child has a diagonal ridge similar to that of living apes. The feature has been proposed as a sign that the child was arboreal.





Too little money leads to too much borrowing and bad financial choices

Experimental findings challenged by other researchers

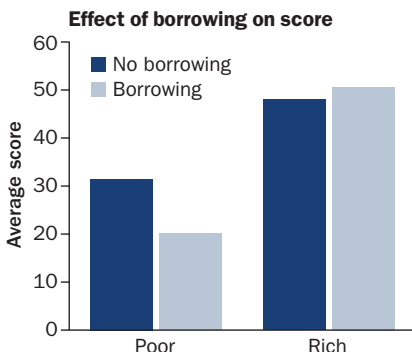
By Bruce Bower

Scarcity — of money, time, food or anything else — focuses the mind on immediate concerns and discourages taking a broader perspective. This “scarcity mind-set” helps to explain why poor people often save too little and borrow too much, and it presents policy makers with an opening to encourage better financial decisions among low-income individuals, a new study concludes.

Some researchers, however, regard this finding as vague and far from ready for policy prime time. They suggest that the study’s lab-based results may have little relevance in the real world. And with a nod toward the recent financial meltdown, some note that inadequate saving by the poor ought to be of less concern than financial recklessness on the part of the wealthy.

When money is scarce, each current expense looms large and draws attention away from less pressing expenses, say psychologist Anuj Shah of the University of Chicago and his colleagues.

In the hole In a *Family Feud*-style game, players who were given less time to answer—the “poor” players—tended to hurt their overall scores by borrowing against future rounds. Rich players, who had more time, performed similarly whether or not they borrowed. SOURCE: A. SHAH ET AL./SCIENCE 2012



For instance, poor people tend to focus on how to pay for groceries today while neglecting to budget for their next rent payment, the researchers propose in the Nov. 2 *Science*.

For the study, the group tested volunteers who received generous or limited amounts of time and numbers of tries on lab games. Participants, most in their late 20s and early 30s, were mainly recruited from an online site for job seekers.

In one experiment, 143 players received 15 seconds or 50 seconds of time per round in a trivia game. Each round consisted of guessing the five most popular survey responses to questions such as “Name things you take on a picnic.” Some participants could borrow additional seconds while playing, but lost the same number or double the number of borrowed seconds later in the game.

In another experiment, 68 players received few or many shots for a sling-shot in an *Angry Birds*-like video game. Players who borrowed against later shots lost double what they borrowed.

“Impoverished” players, those given less time in a game, spent more time on each choice or action, resulting in lower scores on tests of alertness afterward. Given the opportunity during games, these players borrowed a larger proportion of time or tries against their starting amounts than “rich” players did.

Rich players outscored poor players. Having an option to borrow didn’t affect rich players’ scores. Poor players scored lower when they could borrow, especially if they had to pay back

twice what they borrowed.

The results suggest that scarcity of any kind creates a tendency to borrow a needed resource without thinking through the costs and benefits of that strategy, Shah’s team reports. This effect lies behind the popularity of short-term, high-interest loans among the poor, he says.

Poor people do save for the future, but they tend to do so for specific purchases, Shah says. Well-publicized reminders about the need to save for specific expenses should be explored as ways to

increase saving in low-income households, he proposes.

“The same attention mechanism might drive borrowing and saving when resources are scarce,” Shah says.

The findings suggest that extremely poor people often refuse to pay small amounts for basic health services because they focus so intently

on price that they overlook their own health concerns, writes Alix Zwane, a senior program officer at the Bill and Melinda Gates Foundation in Seattle, in the same issue of *Science*.

But it’s hard to know what to make of Shah’s attention-narrowing model of scarcity, says economist Glenn Harrison of Georgia State University in Atlanta. “Poor” participants in the experiments were presumably relatively well-off in real life and not representative of poor people in non-Western countries.

The financial crisis of 2008 and many previous economic calamities involved overborrowing by the rich, not the poor, says economist Nathan Berg of the University of Texas at Dallas. Rich players in the experiments borrowed greater absolute amounts than poor players, Berg notes. Policies that encourage responsible borrowing should target major financial firms and politicians, he suggests. ■

Scarcity of any kind creates a tendency to borrow a needed resource without thinking through the costs and benefits of that strategy, the team reports.

Health & Illness

151
per 100,000Olmsted County annual
heart attack rate
before the smoking ban**101**
per 100,000Annual heart
attack rate after
the smoking ban

Smoking laws lower heart attacks

Minnesota county's restrictions linked with one-third decline

By Nathan Seppa

Perhaps living in a “nanny state” isn’t half bad. In a Minnesota county that banned smoking in public places in 2007, the heart attack rate dropped by one-third after the ban, compared with the period just before restrictions were phased in, researchers report in the Oct. 29 *Archives of Internal Medicine*.

The study is the longest analysis to date to measure a smoking ordinance’s effect on community-wide heart health, says study coauthor Richard Hurt, an internist at the Mayo Clinic in Rochester, Minn.

“Our hope is that this will turn the page on this chapter and whether secondhand smoke is associated with

heart attacks,” Hurt says. “It is.”

Olmsted County prohibited smoking in restaurants on January 1, 2002, and expanded the ban to all workplaces, including bars, on October 1, 2007. Cigarette smoke inhalation increases heart attack risk, so Hurt and his colleagues calculated the rate of heart attacks during the 18 months preceding the enactment of the first ordinance and the 18 months immediately after the full ban went into effect.

When adjusted to account for demographic changes in the county’s population between the two periods, the data revealed an annual heart attack rate of 151 per 100,000 people before the ban and 101 per 100,000 afterward.

The new study and a litany of simi-

lar findings impress even those who promoted smoking bans early on. “Initially, when these ordinances were passed, I don’t think anyone really expected to see such a rapid cardiovascular effect,” says Pamela Ling, an internist at the University of California, San Francisco. “But I think the evidence now — particularly linking smoke-free policies and real medical outcomes — is really quite strong.”

The new data reflect less smoke exposure and probably also less smoking, she says. “One of the arguments was that smoke-free policies would restrict it in the workplace but that people would smoke more at home,” Ling says. “But actually, studies suggest ... that people don’t compensate.”

Hurt hopes the emerging antismoking ethic will now spread to cars, where, he says, “the concentration of secondhand smoke is just amazing.”

Gene controls aspirin benefit

Mutation makes colorectal tumors vulnerable to drug

By Nathan Seppa

The mystery of why aspirin helps some colorectal cancer patients but not others may be partially solved. A new study finds that the drug seems to extend survival in patients whose tumors harbor a specific genetic mutation, while patients lacking the mutation get no survival advantage from regularly taking the pills.

The study, in the Oct. 25 *New England Journal of Medicine*, may lead to standardized testing of colorectal cancer patients for the mutation, in a gene called *PIK3CA*, to see who would benefit from aspirin use.

“We may be witnessing a game changer,” says Boris Pasche, an oncologist

at the University of Alabama at Birmingham who wasn’t part of the study team. “I wouldn’t be surprised to see labs beginning to test for this mutation quickly.”

The study will need to be tested in a larger, more rigorous clinical trial before a *PIK3CA* test becomes part of treatment guidelines, Pasche says. Roughly 15 to 20 percent of patients with colorectal cancers have the mutation.

Researchers analyzed data from 964 colorectal cancer patients, noting patients’ mutation status and aspirin use after being diagnosed with the disease. Among those with the *PIK3CA* mutation, taking the drug dramatically increased survival over those not taking it. Over more than a decade of follow-up, only three of 66 patients, or 4.5 percent, harboring the mutation who took aspirin died of colorectal cancer causes, compared with 26 of 95, or 27 percent, with

the mutation who weren’t taking aspirin.

In 803 patients who didn’t have the mutation, no survival advantage emerged from taking aspirin.

The mutated form of *PIK3CA* may cause the gene to stay switched on, overactivating a biochemical pathway that plays a role in cancer. But precisely how the mutation does this, or how aspirin involves itself in the pathway, remains unclear, says study coauthor Andrew Chan, a physician at Harvard Medical School and Massachusetts General Hospital.

One possible explanation is COX-2, an inflammatory compound implicated in the same biological pathway as *PIK3CA*. Aspirin inhibits COX-2. In 2009, Chan’s team found that aspirin’s benefit was strongest in patients whose tumors made a lot of COX-2. The new data, Chan says, further suggest a connection.

“We may be witnessing a game changer.... I wouldn’t be surprised to see labs beginning to test for this mutation quickly.”

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Onward and Sky

High in Beijing's sky, the August sun glows red by midafternoon, a star struggling to illuminate China's crowded capital from above the dust and pollution.

I'm in the city along with 3,200 astronomers for the International Astronomical Union's two-week General Assembly meeting. It's the first time the IAU has convened the assembly in

China, an important milestone for a country attempting to reclaim its former astronomical significance.

Tradition and modernity squeeze together here, like the cars that navigate the congested streets. A recently expanded subway system zips below the remaining hutongs, narrow alleyways surrounded by stone houses that once formed the nuclei of the city's

neighborhoods. Chang'an Avenue's 12 lanes slice through Beijing's heart, right in front of the Forbidden City's sprawling maze of ornate palaces and colorful temples bejeweled with the sacred symbols of a bygone era.

Like Beijing, Chinese astronomy is at once ultramodern and steeped in the traditions of millennia. For thousands of years, it developed independently from



ward

With new efforts aimed at the stars, China seeks to revive its astronomical reputation

By Nadia Drake

the West, with astronomers watching the shifting skies and inventing instruments to chart the heavens and keep track of time. But after many, many years, the country's intellectual prosperity came to an end.

In 1966, Mao Zedong's regime plunged China into its Cultural Revolution. The decade-long period of turmoil sealed the country's people from the outside world,

incubating policies that would leave lasting scars. Among the many casualties were science and innovation — and China is still struggling to recover from the void in expertise left behind.

"At present, there is still a big gap between Chinese astronomy and Western advanced countries," says Fang Cheng, a solar astronomer at Nanjing University, northwest of Shanghai. "We

have not many large facilities for the astronomy observations."

That's changing, though. Driven by historical, ideological and emotional concerns for greatness, the same political system that had hamstrung Chinese science has been working for two decades to revive it. Bolstered by a growing budget, Chinese astronomy is aiming to unleash a torrent of discoveries in the coming years. World-class telescopes and observatories are making their debut within the country, at the Dome A station in Antarctica and in space. China is in a race to regain its place of prominence in the pantheon of stargazers.

Journey to the past

Along Chang'an Avenue, just east of Tiananmen Square, sit relics of China's astronomical past. Exit the Jianguomen subway station, take a right and look skyward.

Eight astronomical instruments, each hundreds of years old, are poised like sentinels atop an observing platform. Though easy to miss amid the city's hustle-bustle, these bronze, sculpted instruments mark the spot where an observatory once flourished. For centuries Beijing's Ancient Observatory, completed in 1442 during the Ming Dynasty, served as an epicenter for astronomers mapping the stars.

But astronomy in China has much deeper roots. As early as 2400 B.C., Chinese astronomers were charting the heavens. A calendar made at that time used the location of the star Antares to mark the beginning of a year. Four hundred years later, astronomers timed solstices and equinoxes based on Antares and three other stars, an effort described in the Chinese *Book of Documents'* Canon of Yao. Between 1523 B.C. and the end of the Qing Dynasty, in A.D. 1911, Chinese astronomers recorded more than 4,000 comets and more than 1,000 solar eclipses. Ancient records of sunspots are still studied by modern astronomers tracking the solar cycle, says Fang, who also lectures on the history of Chinese astronomy.

Sky-gazers also recorded more than



Various forms of comets were depicted in China's Mawangdui Silk Texts, compiled more than two millennia ago. Ancient Chinese astronomers also mapped the stars and documented supernovas.

90 exploding stars in texts between around 1700 B.C. and A.D. 1600. The most famous, perhaps, is a supernova that occurred in 1054, creating what's now called the Crab Nebula. Several Chinese observations of the 1054 supernova exist, including a description in a history of the Song Dynasty that locates the explosion: "A guest star emerged several [inches] south-east of Tianguan. After more than a year it gradually disappeared."

The Chinese are very polite, Fang says. "They called the exploding stars 'guest stars.'"

In the 13th century, Guo Shoujing invented a collection of sky-mapping instruments, including the simplified armilla — a version of which can be found at the Ancient Observatory. Later, Guo used his instruments to precisely determine the length of a year at 365.2425 days. He then drew up a calendar that served imperial courts for centuries, until the Renaissance brought Jesuit missionaries to China. "At that time, China began to realize that we have to learn much from the Western countries, including the astronomical field," Fang says.

Signs of Western influence still linger at the Ancient Observatory, where the Flemish Jesuit missionary Ferdinand Verbiest served as director in the 17th century. Verbiest designed some of the instruments visible from the subway station: A quadrant from 1673, which can measure celestial altitudes, is festooned with dragons. Nearby, an altazimuth — used to determine celestial angles — sits next to an armillary sphere and a detailed celestial globe. And there is a sextant, a larger and more ornate version of the instruments sailors used to navigate the seas.

In the early 20th century, Chinese astronomy began building its modern foundations. Early bricks were set with the birth of the Chinese Astronomical Society in 1922. Then, in 1934, China founded the Purple Mountain Observatory, based in Nanjing. The next year, China joined the International Astronomical Union.

Soon after, though, astronomy in China came to a violent halt. The defeat of the Kuomintang in 1949 brought Mao Zedong into power. In an attempt to transform China from an agrarian society into an industrialized collective, Mao instituted the Great Leap Forward. Food production slowed, the economy stalled and, by 1961, much of China was in ruins. Needing to regain credibility and power, Mao in 1966 ignited the Cultural Revolution, erasing much of China's historical record and isolating the country from the rest of the world.

Threatened by new ideas, the government dismantled the scientific establishment, targeting intellectuals, educators and scientists. Many were sent to work on farms or in factories. Schools closed. "At that time, the whole system was a mess," says political scientist Richard Suttmeier, professor emeritus at the University of Oregon in Eugene. When the revolution officially ended in 1976, a generation had been denied proper education and scientific expertise had been lost.

Burning bright

Hoping to repair the damage and become an international leader in science and technology, the Chinese government is now investing heavily in astronomical projects, within the country and internationally, as well as in science education.

"It's a recent development," says Cong Cao, a sociologist at the University of Nottingham in England who studies science and technology in China. "It most likely happened at the same time the Chinese economy started to take off."

In 2009, research and development expenditures in China amounted to 580 billion Chinese yuan (about 150 billion U.S. dollars, when adjusted for purchasing power), according to an analysis by the Organization for Economic Cooperation and Development. That figure was roughly 1.7 percent of the country's gross domestic product. By 2020, China hopes to be spending 2.5 percent of its GDP on research and development, which would put it nearer the United States, where R&D spending in 2009 amounted to 2.9 percent of GDP. (Both nations lag behind Japan, which spent 3.4 percent of its GDP on R&D in 2009.)

It's hard to know how much of that money is going toward basic research in astronomy. Fang estimates that total

Blending old and new

China's astronomical past is alive at ancient observatories that served as centers of learning and culture for centuries. But the country is now working hard to catch up with a more modern global astronomy community. Chinese scientists hope new facilities will help their country reclaim its astronomical renown.



government funding for such research in 2012 is around 200 million yuan, up from less than 20 million yuan a decade ago.

Vice president Xi Jinping, one of the Communist Party's highest ranking officials, emphasized the country's commitment to astronomy at the IAU meeting's opening ceremony in Beijing. "Astronomy, as the science to explore the universe, is one of the most important and the most active scientific frontiers," said Xi, the presumptive next president of China. "To explore this vast universe is the common goal of all humankind; astronomy in fast development is the shared fortune of all humankind."

Xi's speech "was a clear indication that Chinese leaders realize the importance of elevating the role of science in education and economic development," says Robert Williams, an astronomer at the Space Telescope Science Institute in Baltimore and former president of the IAU.

About 160 kilometers northeast of

Beijing is a tangible sign of Xi's statements — the Xinglong Observing Station, which hosts China's largest telescope. The station belongs to the National Astronomical Observatories of China and is in the Yanshan Mountains, the same range as the most tourist-soaked sections of China's Great Wall.

At 8 a.m. on a Saturday, I head for the hills with a dozen or so astronomers. Highways so gridlocked that drivers step out of their cars for a leisurely cigarette slowly transform into flower-lined roads curving through villages and rounded, limestone mountains that appear to bubble up from the Earth.

Nearly three hours in, I spot the observatory sparkling atop a distant ridge. Domes protruding from the hills resemble a line of bread crumbs leading to Chinese astronomy's most treasured gem: A new, futuristic-looking telescope known as LAMOST, short for Large Sky Area Multi-Object Fiber Spectroscopic Telescope. Also called the Guo Shoujing

Telescope, the instrument has two parts: a classically shaped dome and a detached tunnel rising up from it at an angle. A chance to scramble around inside the telescope's guts reveals the honey-combed mirrors that bounce light back and forth, and the knotted electronic nerve center that processes incoming photons.

Completed in October 2008, at a price tag of 235 million yuan, the 4-meter telescope is considered a National Major Scientific Project. Now the largest optical telescope in China, it dethroned the 2.16-meter reflector that lives in the next dome over.

For the last few years, scientists have been troubleshooting LAMOST and conducting pilot surveys. Once science observations are under way, LAMOST will point toward the star-splashed center of the Milky Way, uncovering clues to the galaxy's structure and evolution. Over an observing period of five years, astronomers plan to study more than



Beijing Ancient Observatory

Built in the 15th century, this observatory served as a station for astronomers to track the movements of the heavens and assist in sea navigation. Today, historical Chinese instruments are on display here.



Purple Mountain Observatory

In operation since 1934, Purple Mountain is China's first modern astronomical observatory. Located in Nanjing, it was the only modern observatory until 1962. Most of China's 20th century efforts have their origins here.



Gaocheng Observatory

Designed by Guo Shoujing in the 13th century, the Gaocheng Observatory has a long stone path in front, designed to measure the sun's shadow. Gaocheng was built on a site used for observing since around 300 B.C.



Xinglong Station

This observatory is the site of the newly installed Large Sky Area Multi-Object Fiber Spectroscopic Telescope, LAMOST. Once it is fully operational, the 4-meter optical scope will survey millions of stars and galaxies.



FAST

In southwest China, the Five-Hundred-Meter Aperture Spherical Telescope, or FAST, is now under construction (model shown). When complete, this radio scope will dwarf the current largest, near Arecibo, Puerto Rico.

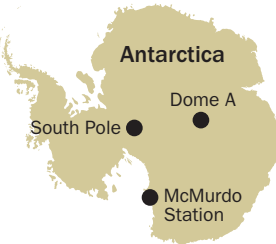


Sheshan Station

This observational site of the Shanghai Astronomical Observatory currently hosts a 25-meter radio telescope (shown). A 65-meter, fully steerable version is now under construction.

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Looking south China set up an automated space observatory at Antarctica's Dome A in 2008 (shown is an astronomer on the inspection team). A trio of telescopes is expected to debut at the site by 2015.



10 million stars and millions of distant galaxies.

LAMOST is just one prong in China's all-out astronomical assault.

In the south, researchers are installing what will be the world's largest radio telescope. When complete, the dish — called FAST for Five-Hundred-Meter Aperture Spherical Radio Telescope — will be almost 200 meters wider than the 305-meter telescope near Arecibo, Puerto Rico. Nestled into a depression in the karstic terrain of Guizhou Province, and coming in at a cost of about 700 million yuan, FAST should see first light in 2016, says astronomer and project chief scientist Nan Rendong of China's National Astronomical Observatories.

Because of its extreme sensitivity, the telescope's impact on astronomy will be enormous, Nan says. "Its unique contributions to science may not yet be predictable." Observation targets include pulsars, interstellar molecules and distant, gassy galaxies. It might also listen for signs of intelligent extraterrestrial life.

As China develops facilities across the mainland, it is also expanding to the Antarctic. Already, the country has a few scopes on the icy ground at Dome A. At 4,000 meters elevation, the site is the highest point on the continent's plateau. Clear, dry air and four months of wintry darkness make Antarctica an ideal observing site, says astronomer Lifan Wang, director of the Chinese Center for Antarctic Astronomy and a professor at Texas A&M University in College Station. "To have an observatory in that

place, I'm thrilled," Wang says. "It's like an outpost on a planet that's not Earth."

Debuting by 2015 will be the Antarctic Survey Telescope, a trio of eyes that will stare at the sky, waiting for stars to explode, observing galactic nuclei and looking for exoplanets. Wang has studied supernovas for decades, and was a member of one of the teams that in the 1990s used them to determine that the expansion of the universe is accelerating.

A trial run had the first of three scopes staring at the galactic center and the Large Magellanic Cloud earlier this year. The second eye will be installed next year, and the third in 2014, Wang says.

Farther afield still will be the Hard X-ray Modulation Telescope, China's first astronomy satellite. Tasked with observing black holes, the Earth-orbiting scope could launch as early as 2014, Su Dingqiang, an astronomer and member of the Chinese Academy of Sciences, said at the IAU opening ceremony. Additional orbiters are planned for the

coming decade, including solar observatories and a dark matter probe. These instruments will be joined by China's space station, set for completion in 2020. Though expected to be smaller than the International Space Station, China's version should be operational by the time the ISS is retired into the Pacific Ocean.

In Chinese astronomy's broad reach, the solar system's planets and other residents could be the targets that are missed, Williams says. A lunar lander is tentatively on the schedule, but most of the country's off-planet endeavors are aimed toward human spaceflight and the new space station. In 2003, China became the third country to independently send people to space, and orbital rendezvous are currently being demonstrated with the test module Tiangong-1.

Still, Williams says, China has been intelligent with its investments, paying attention to different disciplines, joining international collaborations and creating training opportunities. "They are putting much effort into developing young scientists, which is really the key to their future," he says.

The human factor

To translate first-class facilities into first-rate science, China will need to overcome the policies that left a void in its science community. "There's no doubt that something big is happening in China with science and technology," Suttmeier says. "But the problems are also enormous."

As a result of the Cultural Revolution, China's existing stable of astronomers is

In preparation for a future space station, China launched the test module Tiangong-1 in September of last year.



relatively young and inexperienced. And the country's educational system isn't set up to foster the kind of creative thinking that leads to innovation. "In the process of your education, you have been taught to do whatever you're asked to do," Cao says. That means memorizing facts, passing tests and obeying your professor.

What's more, many of China's best minds end up leaving the country to work or study overseas. China is coming up with ways to combat this brain drain, which has seen at least a million of China's people seek foreign education since 1978. In 2008, the country established the Thousand Talent program, designed to attract 2,000 scholars back to China over the next several years.

At the same time, China is trying to become a magnet for scientists and scholars from afar, which Suttmeier says will be crucial for success. In 2011, the government announced the Thousand Foreign Experts project, which aims to attract 1,000 foreign scientists to China over the next decade. But one problem with such schemes is the limited career advancement opportunities for foreigners in China. "As long as the Communist Party is running China, it's hard to imagine foreigners who are not party members taking critical positions in research institutions," Suttmeier says.

While Chinese astronomers frequently collaborate with scientists from many nations, including Australia, the United States and those in Europe, some relationships can present challenges.

Currently, many U.S. government-funded scientists aren't allowed to participate in one-on-one collaborations with the Chinese. In 2011, Congressman Frank Wolf inserted language into an appropriations bill prohibiting researchers at some agencies from working bilaterally with the Chinese. When the White House Office of Science and Technology Policy ignored the prohibition, Congress cut its 2012 budget by 32 percent.

Asked about how the restriction is affecting collaborations with Chinese astronomers, officials at NASA declined to comment, but did say that Public Law 112-55 prohibits NASA from engaging in

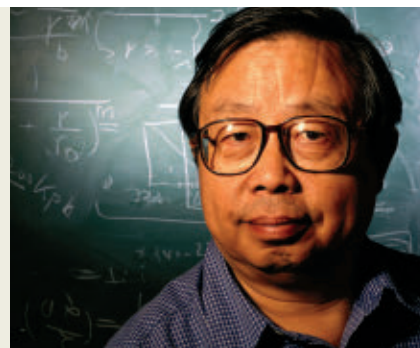
Ideological run-in

Political ideology and science clashed throughout the life of Fang Lizhi, one of China's most famous astrophysicists.

Fang, born in 1936 to a working-class family in Beijing, was initially interested in physics. As one of the most brilliant minds of his generation, he studied at Beijing University and became involved in an early attempt to develop nuclear weapons in China. But by the late 1950s, he had fallen out of favor with the rising Communist Party, because of an essay criticizing political intervention in scientific discourse.

When the Cultural Revolution struck, Fang was one of many academics targeted. He was sent to work in a coal mine in 1967. But he managed to hold onto an astrophysics textbook and teach himself cosmology. After some time in a brick factory, Fang returned to academia. In the early 1970s, he published the first modern cosmological paper in China, about the Big Bang and a finite universe. The Communist Party objected again. (Marxist philosophy espoused an infinite universe.)

For almost two decades, an uneasy truce allowed Fang to stay in the country, though he was expelled from the Communist Party when his political activity helped spark student demonstrations. Following the Tiananmen Square protests, Fang sought asylum in the West. He eventually settled in the United States, where he would remain, studying astrophysics and cosmology at the University of Arizona until his death earlier this year. —*Nadia Drake*



bilateral collaborations with China.

"They are so intimidated by this language," says Joan Johnson-Freese, who studies the intersection of space policy and national security at the U.S. Naval War College in Newport, R.I. "Nobody wants to test that. There is fear — and I use that word, and you can quote me on that — there is fear of being in a room with a Chinese researcher if you're from NASA."

So although China is laying a new foundation with instruments and trying to glue its bricks together with training programs, a lot of work remains. "I don't think in the near future we can play a leading role in the world," Fang says. "Probably after many years, then we can catch up."

Still, efforts that require many years elsewhere often happen quickly in China. All but two of the Beijing subway's 15 lines were built in the last decade. The Great Hall of the People, built to celebrate the country's 1959 anniversary,

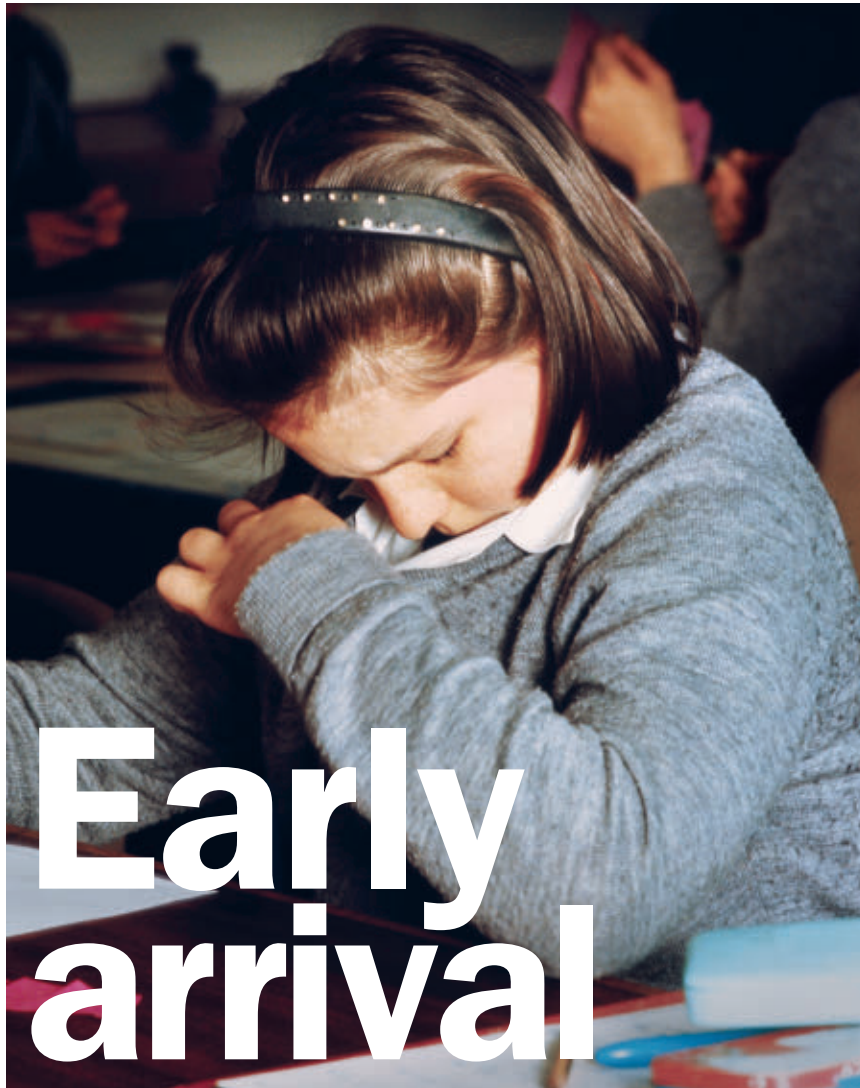
was erected in just 10 months. And in preparation for the 2008 Olympics, China constructed the enormous, ultra-modern Terminal 3 at the Beijing airport, reportedly in four years.

Leaving China through that Olympic terminal, I notice a replica of one of the instruments in the courtyard at the Beijing Ancient Observatory. Four green-hued, spiky-spined and sharp-clawed dragons work together to hold aloft a gigantic sphere. The sphere's skeleton seems exposed, with giant bands of metal curving around the empty space at its heart. It is based on an armillary sphere that dates back to 1439.

Here, set amid one of the busiest gateways to the outside world, travelers pause for pictures with a symbol of China's astronomical past. ■

Explore more

■ Learn more about the IAU General Assembly meeting in Beijing: www.astronomy2012.org



Early arrival

Premature puberty among girls poses scientific puzzle

By Laura Beil

Kotex, the company that first capitalized on the concept of “feminine hygiene” more than 90 years ago, recently gained newfound success after it began targeting an underserved market: girls who start their periods before they start middle school. With hearts, swirls and sparkles, the U brand offers maxi pads and tampons for — OMG! — girls as young as 8, promoted through a neon-hued website with chatty girl-to-girl messages

and breezy videos. “When I had my first period I was prepared,” reads one testimonial. “It was the summer before 4th grade....”

Today it has become common for girls to enter puberty before discovering *Are You There God? It’s Me, Margaret*. Over the second half of the 20th century, the average age for girls to begin breast development has dropped by a year or more in the industrialized world. And the age of first menstruation, generally around 12, has advanced by a matter of months. Hispanic and black girls may be experiencing an age shift much more pronounced.

The idea of an entire generation maturing faster once had a strong cadre of doubters. In fact, after one of the first

Breast development among girls generally begins between age 8 and 13. New studies suggest it is not abnormal for girls to go through puberty earlier.

studies to warn of earlier puberty in American girls was published in 1997, skeptics complained in the journal *Pediatrics* that “many of us in the field of pediatric endocrinology believe that it is premature to conclude that the normal age of puberty is occurring earlier.” Today, more than 15 years later, a majority of doctors appear to have come around to the idea. Have a conversation with a pediatric endocrinologist, and it isn’t long before you hear the phrase “new normal.”

“If you basically say that the onset of puberty has a bell-shaped distribution, it seems to many of us the whole curve is shifting to the left,” says Paul Kaplowitz, chief of the division of endocrinology and diabetes at Children’s National Medical Center in Washington, D.C. More girls, he says, are starting puberty before age 8, putting them at “the lower end of the new normal range.”

Researchers are now turning their attention to what could be driving the trend. Many scientists suspect that younger puberty is a consequence of an epidemic of childhood obesity, citing studies that find development closely tied to the accumulation of body fat. But there are other possibilities, including the presence of environmental chemicals that can mimic the biological properties of estrogen, and psychological and social stressors that might alter the hormonal makeup of a young body.

These possibilities could also be occurring simultaneously in ways that are not understood. A study published in September in the *Journal of the American Medical Association* found that children with high levels of a common environmental pollutant were more likely to be obese. “Although I’m convinced that obesity is part of the story, I’m no longer convinced it’s the whole story,” Kaplowitz says.

Scientists hope more research will help explain why the puberty trend for boys

isn't as clear as it is for girls, though a recent study in *Pediatrics* does suggest that boys, too, may be maturing earlier. The concern is not parental squeamishness but the potential for future health consequences. Children reaching puberty too young, some data suggest, face a higher risk of cancer, bone fractures and other problems in adulthood. Doctors also fear a body that belies true age, especially in girls, could put children at risk for sexual abuse and other problems.

"The early maturing girl has greater vulnerabilities and is more likely to be involved in risky behaviors," says Frank Biro, director of adolescent medicine at Cincinnati Children's Hospital Medical Center. When a 9-year-old looks 12, "her peers and adults take the cues from what she looks like. But she's still a 9-year-old."

Earlier than thought

Observations of sexually abused girls are what helped launch the scientific study of early puberty. In the 1980s, Marcia Herman-Giddens was evaluating such girls as a physician's associate at Duke University Medical Center. She began to notice that patients as young as 5 were coming to the doctor with breasts and pubic hair. To Herman-Giddens, this seemed awfully young, but the best references she could find for comparison was a British study conducted decades earlier.

To try to find out if the girls in her office were somehow on an accelerated time line, she began compiling information, first publishing small investigations and then looking at more than 17,000 girls seen at 225 pediatricians' offices. She reported the larger study in 1997 in

Pediatrics. At the time, Herman-Giddens says, the generally accepted average age for puberty onset was about 11. She and colleagues found that, on average, black girls were beginning to develop breasts and pubic hair before age 9, and white girls around age 10 and a half. Her earlier studies had already hinted at racial differences in the timing of puberty, she says. "The thing that shocked us was the girls were developing much earlier than everyone thought."

The report ignited pointed debates. "There were a couple of groups of pediatric endocrinologists who said, 'We can't sign onto this,'" Biro says. One of the criticisms was that, by drawing data from doctors' offices, the 1997 study might have overrepresented girls brought in by concerned parents.

Soon after, Biro and colleagues gathered data on a cross section of American girls for a research project into possible environmental contributors to the onset of puberty. The new findings, published in 2010 in *Pediatrics*, support the idea that girls are developing breasts earlier, with results that vary widely by race.

By age 7, Biro's team found, breast development was occurring in about 10 percent of white girls, 23 percent of black girls and 15 percent of Hispanic girls. By age 8, the numbers rose to about 18 percent of white girls, 43 percent of black girls and 31 percent of Hispanic girls. All of these proportions were greater than those found in older studies, including Herman-Giddens' research.

"Clearly what we consider normal today, 20 or 30 years ago would have been considered precocious puberty," Biro says, using the medical term for

extremely young puberty. Other studies have also been consistent with the idea that puberty is occurring earlier, including a 2009 study from Danish researchers that put breast development about a year earlier among girls studied in 2006 compared with girls studied in 1991, and put the age of first menstruation more than three months earlier.

The diet debate

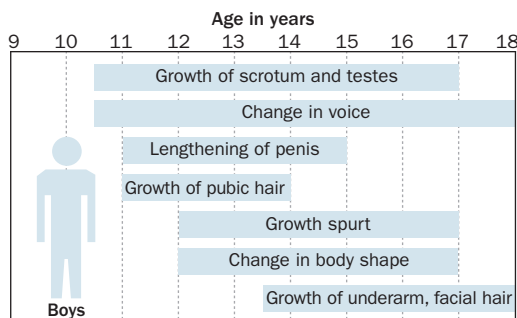
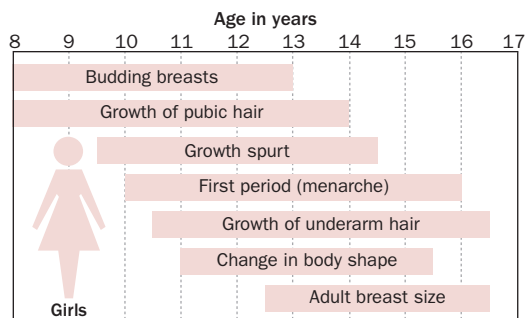
Childhood obesity tops the list of suspects that might account for this change. The percentage of American children who are obese has tripled over the last 30 years, now at about one-fifth of children and adolescents. The timing of the obesity epidemic roughly corresponds with the apparent drop in age of puberty.

There's a certain evolutionary logic to a tie between body fat and reproduction, says Kaplowitz. "If there's a decrease in food supply and your body fat stores decrease, it would not be an optimal time for your body to support a pregnancy," he says. But once a girl's body contains enough fat for the energy demands of reproduction, hormonal signals start clearing the way for sexual maturation.

As early as the 1960s, researchers noted that sexual maturation in rats correlated more closely with body size than age. More recently, studies in people find a similar connection. In 2007, a study in *Pediatrics* reported that, among other findings, a girl's weight as early as age 3 could predict her odds of going through puberty before her peers. Later research follows the same pattern. Last year in the journal *Fertility and Sterility*, scientists reported on a group of more than 3,000 girls born in Denmark in the 1980s. The

Growing up

Puberty is a multiyear process that has no clearly defined beginning or endpoint, making it difficult for researchers to study. While a girl's age at her first period is a clear measure, other steps in the development of young bodies are more gradual.



SOURCE: WWW.MERCKMANUALS.COM

team recorded the girls' ages when menstruation began, and determined body mass index (a measurement of weight in relation to height). For every point increase in body mass index, based on weight and height reports from mom, the age of first menstruation dropped by about a month.

Scientists cannot conduct direct experiments testing overeating's effects on puberty, and it is hard to sort out other contributors such as genetics, environment and activity levels. But researchers from the University of Wisconsin–Madison recently measured how eating more affects the timing of puberty in monkeys. In April, the scientists published a study of four female juvenile monkeys raised in the same extended family colony and randomly assigned to have snacks every morning and afternoon. The treats increased the monkeys' calorie intake by about 30 percent compared with four monkeys on a regular diet. Everything else between the two groups of monkeys, including living conditions and activity levels, remained almost identical.

Less than a year later, all of the monkeys with extra food had begun menstruating, but none of their cage mates had, the scientists reported in *Endocrinology*. The monkeys eating more also experienced puberty earlier than previous generations of the colony. "We were surprised," said physiologist Ei Terasawa, who led the research. "The only change was the diet."

At issue is probably not weight gain alone but fat, researchers say. One of the main biological conduits between obesity and puberty—for girls, at least—occurs through the hormone leptin, released by fat tissue to notify the brain about the body's energy stores. Research has found that leptin levels rise before puberty. Other clues point to leptin, too: Mice born with an inability to produce leptin, in addition to becoming obese, do not go through puberty. Neither do people who are born with genetic abnormalities that interfere with leptin production.

In boys, the onset of puberty is more gradual and thus harder to measure than it is in girls. But if obesity is a big contributor to the trend, boys might be less affected. The role of body fat and related hormonal cues are probably less important, or more complex, in male development.

Even among girls, the endocrinology is far more complicated than leptin alone—it is not the only puberty-related hormone affected by obesity. The female hormone estrogen, too, is key for breast development. Although fat tissue can also produce estrogen, when it comes to triggering puberty, "the role of estrogen is more controversial," Biro says.

Pollution and puberty

Nonetheless, estrogen is central to another early puberty hypothesis. That is, whether the estrogen-like qualities of some chemicals, including

environmental pollutants, are to blame. It's known that many substances used in plastics, pesticides, detergents and other products can mimic the effect of estrogen in animals, sometimes dramatically. Exposure to these compounds can even cause male reptile and bird hatchlings to become feminized.

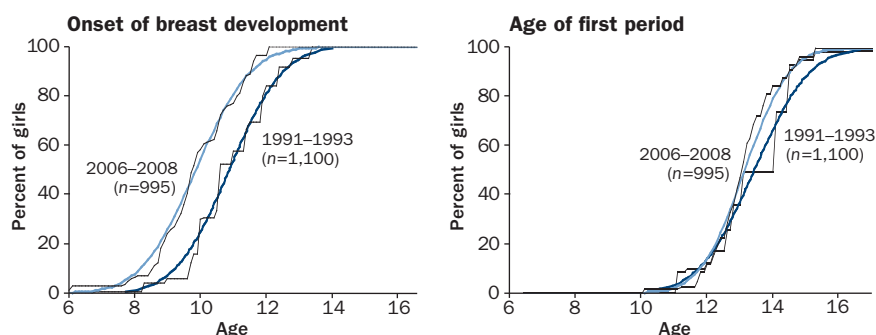
Studies have pretty consistently found that the timing shift in breast development appears to be greater than in menstruation, Finnish and Danish researchers wrote in 2010 in *Molecular and Cellular Endocrinology*. Since breast tissue is more sensitive to estrogen than is menstruation, "the reason for the development of glandular breast tissue at much younger ages over a short period of time must be of environmental origin," wrote scientists from Turku and Copenhagen.

Among the list of suspected culprits are polychlorinated biphenyls (once used in electrical transformers and capacitors), polybrominated biphenyls (found in some flame retardant materials), phthalates (added to plastics, and even beauty products) and dioxins (a common industry by-product). Among more than a dozen human epidemiological studies reviewed by the researchers, the results were mixed. While some found that exposure to pollutants sped up puberty, others found a delay in puberty or no effect.

A study in November in *Environmental Health Perspectives* shows the difficulty of studying any one environmental exposure. Researchers from the U.S. Centers for Disease Control and Prevention in Atlanta examined urine samples from girls ages 12 to 16, looking for an association between a variety of environmental chemicals and the reported age at which menstruation began. The team found an effect for 2,5-dichlorophenol, the breakdown product of an ingredient commonly used in mothballs and toilet deodorizers. But other chemicals examined did not appear to have an effect.

A grab bag of results isn't surprising, said chemist Mary Wolff, who heads the Center for Children's Environmental Health and Disease Prevention Research at Mount Sinai School of Medicine in

Timing shifts Data comparing two groups of European girls suggest that the age of onset of breast development has advanced since the early 1990s (left). A trend in age at first period also emerged in the study, but was less pronounced (right). Changes in levels of reproductive hormones and in body mass index did not account for the findings.



SOURCE: L. AKSGLAED E ET AL/PEDIATRICS 2009

New York City. Some studies aren't valid because they measure chemical exposure through blood samples, she says, when its presence can be detected only in urine. A study may measure only a few chemicals individually, when in fact an effect may require a certain combination. Or the effect may be real but drowned out in study results by the greater influence of body fat and genetics.

Wolff is hoping that a study under way now will help eliminate many of these uncertainties. The U.S. government-funded project is following more than 1,200 girls ages 6 to 8 recruited before puberty. As they grow older and sexually mature, the girls' environmental exposures are being monitored. "There will be some papers in the next year," she says. "I think they will be very informative."

Another complicating factor may take years to work out. There could be a yet-unknown window of exposure that makes a difference; perhaps, for example, an exposure has an effect early in life, but not as the time of natural puberty approaches.

"What concerns me is that most studies are looking at exposures at the time of puberty," Wolff said. "With all environmental exposures, you have to measure at a time that fits with the window of action. I'm beginning to suspect it is early in life."

Stress test

A third area of investigation into early puberty is trying to determine the influence of a girl's physical, social and emotional surroundings. A wide body of research supports the idea that an undercurrent of stress in early life affects timing of puberty, probably by activating hormonal responses to danger, says psychologist Julianna Deardorff of the University of California, Berkeley's School of Public Health. Still, when Deardorff began researching stress and puberty more than a decade ago, she says, "I came at it very skeptically."

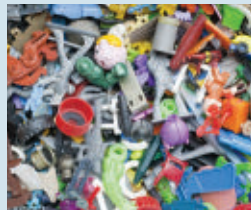
Experiments since then have changed her mind. Among them: Last year, in *Development and Psychopathology*, she and her colleagues reported that

Placing puberty blame

Scientists now agree that the age of onset of puberty is shifting, at least among girls. But the culprit behind that shift is not yet known. Recent studies point to a number of possible contributors that could be acting on their own, together or with unexplored factors to explain the trend.



Obesity Studies in animals and humans suggest that puberty onset is tied to weight. The connection makes some physiological sense: Excess fat signals plentiful times, and thus a body capable of supporting reproduction. But studies that remove compounding factors are hard to conduct and have not been conclusive.



Pollutants Flame retardant materials, chemicals in old transformers, components of plastics and industry by-products are suspects in the puberty timing shift. But epidemiological studies have offered mixed results. The role of these pollutants may depend on the population being studied and the timing of exposure.



Stress Recent work suggests that children who have poor relationships with parents are more likely to go through puberty earlier, but only if they also have a high biological sensitivity to stress. Another study, which controlled for household income and body weight, links absence of a father to premature puberty.

children who showed a high sensitivity to their circumstances (as measured by biological reactions to stress) were more likely to undergo puberty earlier if they also had poor relationships with their parents. Also last year, in the *Journal of Adolescent Health*, Deardorff and her colleagues published a study linking the absence of a father to earlier puberty. The researchers, who followed girls for two years beginning before puberty, reported that the finding held even after they accounted for household income and weight.

Previous studies had suggested that the stress of being raised in a single-parent household might lead to early puberty, but many had failed to account for the influence of obesity, income, ethnicity and other possible factors.

While the influences of stress and living conditions are still under investigation, it is not far-fetched to think that the body would respond to its surroundings, Deardorff says. Recent studies are helping scientists understand much more about how experience can change which genes get turned on or off in any particular circumstance. When life

begins without excess anxiety, she says, "the signal is, this is a safe world and I can delay reproduction."

Questions about early puberty would be easier to answer if sexual development itself were better understood, says Patrick Chappell, who researches the molecular and cellular biology of sexual development at Oregon State University in Corvallis. Puberty occurs when a young body reaches some precise combination of genetic programming, metabolism and environmental stimuli, all of which correspond to a biological calendar set over the course of human evolution. The hormones involved in this transition have been well studied, but how exactly they are awakened is still unknown, he says.

"What influences the timing of puberty?" Chappell says. "In order to know that, you have to know why it happens in the first place, and we don't." ■

Explore more

■ F.M. Biro, L.C. Greenspan and M.P. Galvez. "Puberty in girls of the 21st century." *Journal of Pediatric and Adolescent Gynecology*. October 2012.

How Ancient Europeans Saw the World

Peter S. Wells

Human vision is a curious sense, providing the brain with information about the external world, but not interpreting it. Vision provides only raw data; the brain's innate Photoshop software constructs a visual reality that depends on how the brain has learned to comprehend what it sees. In other words, thinking and seeing are not separate. So when Wells writes about how ancient Europeans "saw the world," he means that both literally and figuratively—how they saw the world, and how they thought about it, as reflected in the objects they made.

Wells focuses on temperate Europe (north of the Mediterranean) from about 2000 B.C. to Rome's conquest of those areas (roughly 50 B.C. to A.D. 50). Historical knowledge about those ancient Europeans is based mostly on Roman sources. Consequently, Wells contends, much of that history is misleading. He relies on archaeological evidence to reconstruct the visual

world of early Europeans, emphasizing their most salient surviving objects—pottery, fibulae (clothing pins, like brooches), swords and scabbards.

Until about 500 B.C., styles of such objects reflected their connection to the natural environment, and designs and decorations on them expressed individuality. But as Europeans became more



aware of the rest of the world and their place in it, object designs reflected concern with the social environment and a sense that individuals belonged to a community. About

three centuries later came a second design revolution, influenced by the constraints of mass production as commerce developed with distant lands.

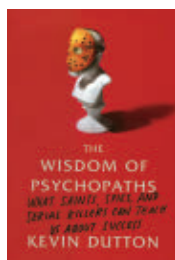
With painstaking detail, Wells documents how objects tell the early European story, making a compelling case that historians ought to rethink the standard views. —*Tom Siegfried*
Princeton Univ., 2012, 285 p., \$35

The Wisdom of Psychopaths: What Saints, Spies, and Serial Killers Can Teach Us About Success

Kevin Dutton

"My father was a psychopath," Dutton admits in his introduction. Never violent, Dutton's dad was charming, ruthless and fearless. He wasn't Hannibal Lecter, just a very good salesman.

Dutton, a research psychologist, believes that his father's case is not



unique. Recent studies are blurring the lines between the psychopath and the average person. The disorder, it turns out, is more of a spectrum than an all-or-nothing state, and not all psychopaths are criminals.

In fact, Dutton argues, some of the traits that make the Ted Bundys of the world horrifying—charisma,

emotional detachment and the ability to focus under pressure—could give top neurosurgeons their edge, or bomb disposal personnel their steady hands and steely nerves. The most successful politicians, CEOs, soldiers and even journalists seem to benefit from a little psychopathic edge.

To support this idea, Dutton digs into research about what the psychopathic brain does—or doesn't do—when confronted with mental tests and moral conundrums. He interviews psychopaths, both in psychiatric hospitals and in white-collar jobs, and the neurologists who study them.

Dutton deftly navigates through some disturbing subject matter, but his message is ultimately upbeat: Scientists may be able to learn a lot from the darker side of human nature.

—*Allison Bohac*

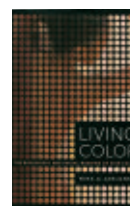
Scientific American/Farrar, Straus and Giroux, 2012, 261 p., \$26



I, Lobster

Nancy Frazier

More than just a tasty meal—though this book does include recipes—the lobster is a star in history, art and science. *Univ. of New Hampshire*, 2012, 254 p., \$24.95



Living Color

Nina G. Jablonski

An anthropologist examines the evolution of human skin pigmentation, its relation to health and the role of skin color in social history. *Univ. of California*, 2012, 260 p., \$29.95



On a Farther Shore

William Souder

Fifty years after the publication of *Silent Spring*, a biographer creates a sensitive portrait of Rachel Carson's life and research. *Crown Publishers*, 2012, 496 p., \$30



Measurement

Paul Lockhart

A mathematician untangles the basic concepts of symmetry, shapes and measurements in a reader-friendly way. *Harvard Univ.*, 2012, 407 p., \$29.95



The Stardust Revolution

Jacob Berkowitz

The author describes efforts by astrobiologists to put the origins of life into a cosmic context in this comprehensive history of "stardust science." *Prometheus*, 2012, 376 p., \$27

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To spot a planet

"Planetary peekaboo" (*SN*: 9/22/12, p. 26) says that to hunt for faraway planets, the Kepler spacecraft "watches for blinks occurring when a planet dims a star's light by passing in front of it." For a star to dim when a planet moves in front of it requires us to be in the same plane as the orbits of the remote planets. Evidently it's expected that this is commonly true. Why is that?

Bryan Mumford, Santa Barbara, Calif.

That's correct: To see a planet passing between Earth and its star, the system and Earth need to be aligned just right. Astronomers don't expect this to be common. On the contrary, they've calculated that only about 1 percent of planets in an Earthlike orbit would be aligned to produce a transit. So, in general, spacecraft like Kepler can detect only a fraction of the planets that may be out there. Imagine how many more there could be. —Nadia Drake

Time to tweet

I read the Twitterverse article ("Social media sway," *SN*: 10/20/12, p. 22) with somewhat mixed feelings. While I am in no hurry to be connected, I recognize in the social media revolution a larger communication revolution that is maturing at a serendipitous time indeed. We can take it as given that global warming will wreak havoc with agriculture as we know it, which in terms of industry, markets and politics will really put the squeeze on our species globally. We are going to need the best possible means of discussing problems related to the survival of life on this planet in the course of the coming century.

Ron Elbert, Somerville, Mass.

Although you acknowledge that misinformation has played a role in many elections in this nation and has impacted political allegiances throughout history, the article implies that

technology changes its significance. Our founding fathers said that an ignorant electorate will destroy our republican-type democracy. What I see is not a danger from technologic information dissemination, but the danger of indifference to facts or knowledge. Politics is about power, and power only. Everyone wants to be on the winning side.

Carolyn Lawson, online comment

Studying suicide

Perhaps the key to preventing abuse-related suicide ("Suicidal threads," *SN*: 11/3/12, p. 20) lies in studying the experience of resilient, happy adults who have overcome a traumatic childhood. Why not start by interviewing any well-adjusted siblings who shared the victims' childhood environment?

Barbara Fenner, via e-mail

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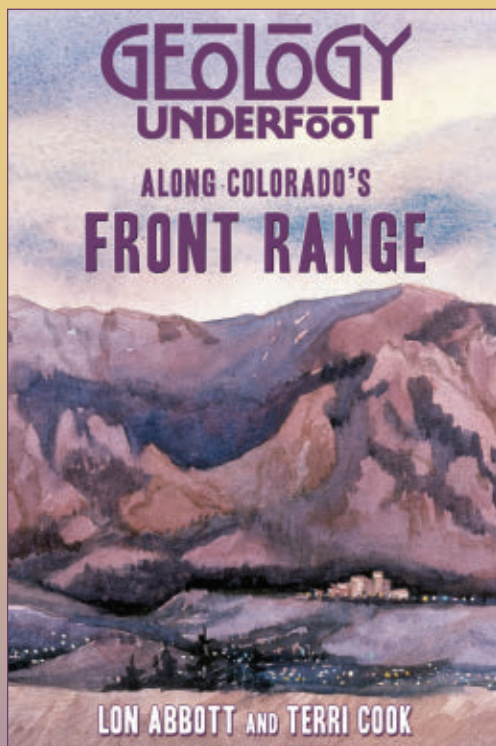


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The Science Life



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Howie Choset is building a new generation of snakelike robots that can climb trees and perform other serpentine feats.

Building robots that slither

Howie Choset is a roboticist, but his team's creations bear little resemblance to C-3PO or R2-D2. Instead, Choset finds inspiration in nature — specifically, snakes.

“A lot of people have this notion that robots are modeled after people,” says Choset, of Carnegie Mellon University in Pittsburgh. But the animal kingdom is full of organisms that use different types of locomotion, he says.

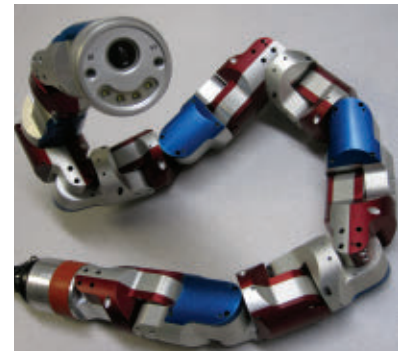
The snake robots in Choset's laboratory can slither, roll, swim and climb straight up. These slender machines, usually built from a series of metal pieces containing motors and electronics, can also squeeze into tight spaces.

Choset (below) enjoyed motorizing toys as a kid, and in high school he built a robot that could maneuver around obstacles. He first encountered snakelike robots in his graduate adviser's lab at Caltech and realized that the machines could navigate a greater range of environments than typical robots, such as small openings, uneven surfaces and poles. “If you have to cross a field, swim a moat, burrow through a little hole in a fence and climb a pole, there's no other robot that can do all those things,” says Choset. He now has his own menagerie of serpentine bots, with the latest red, white and blue version (above right) dubbed “Uncle Sam.” His team wrestles with challenges such as developing algorithms to control the robots' many independent joints and figuring out the right gaits to overcome specific obstacles. To ascend a pole, for instance, the robot must twist into a helix and roll upward.



Choset hopes that snakebots could one day help rescue workers find victims in collapsed buildings after an earthquake or terrorist attack. Over the last couple of years, he has run tests of his team's robots in rubble at a rescue-worker training site in Texas called Disaster City. And last year, Choset visited Egypt to explore the possibility of sending snake robots into archaeological sites to search for artifacts.

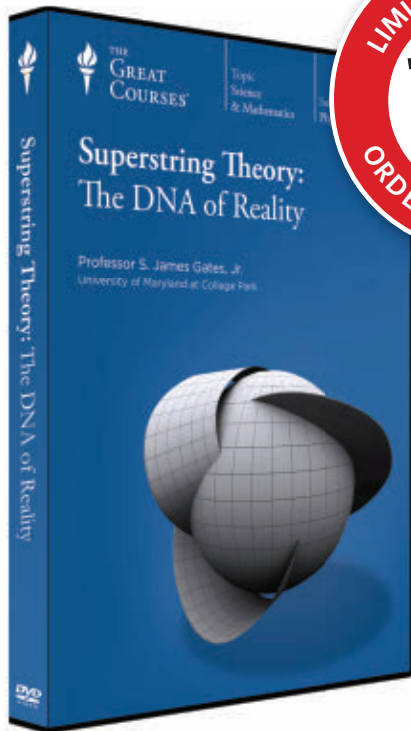
His lab has also made a snakebot that may enable less invasive heart surgery. Instead of opening a patient's chest, a surgeon could guide the robot to the heart through a small hole, then thread a surgical tool through the robot. — *Roberta Kwok*



How snakebots groove

A snakelike form gives robots versatility in how they move. Choset and his team have designed snakebots that mimic a variety of styles of motion seen in nature.

- **Crawl** A snakebot inches across flat surfaces by moving its body up and down in a wavelike pattern.
- **Squeeze** To fit through tight spaces, such as a pipe, snakebots twist and spiral forward like a corkscrew.
- **Climb** A snakebot can wrap its body around a tree trunk, or any vertical pole, and roll itself up and down.
- **Swim** A buoyant snakebot can slither across a body of water like a real snake does, provided it's wearing protective waterproof skin.



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