Bionic Blood Sugar Control

For 14 years, ever since his son was an infant, Edward Damiano has worriedly checked on David as he slept. David has Type 1 diabetes and cannot regulate his blood sugar. His pancreas fails to produce and release two hormones: insulin, which lowers glucose levels in blood, and glucagon, which pushes glucose back up again. Despite insulin injections and regular monitoring, diabetics are whipsawed between extremes: High blood sugar degrades their organs over the years, while low blood sugar at any time can be fatal. Damiano feared that David could die of severe hypoglycemia in his sleep, what parents of diabetic children sometimes call "dead in bed syndrome."

Edward Damiano (right) helps his son, David, with his math homework.

An associate professor of biomedical engineering, Damiano was in a position to help his son. "Years ago," he says, "I started thinking about a two-hormone system that would make automatic therapeutic decisions."

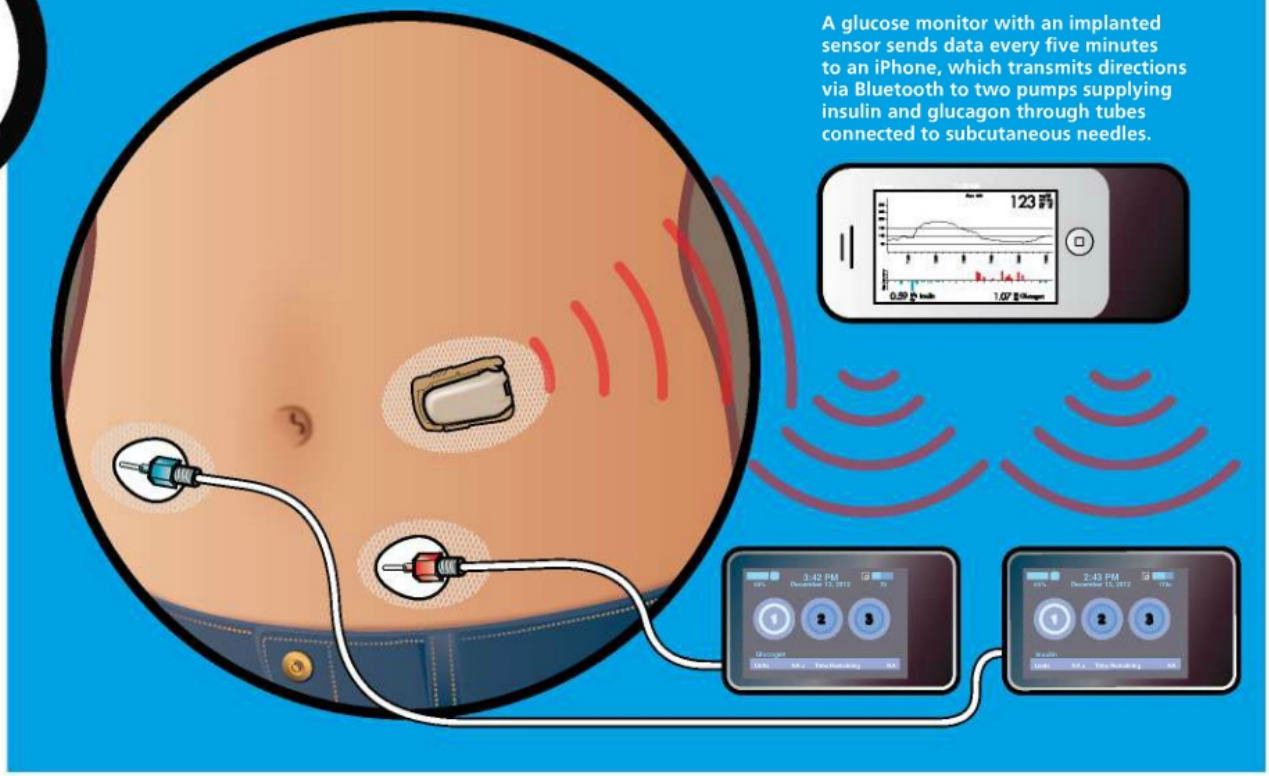
In June, Damiano's team of doctors and engineers at Boston University and Massachusetts General Hospital demonstrated that system, the so-called bionic pancreas. It consists of a glucose monitor, which checks the blood sugar via a sensor under the skin, and two pumps, also connected to the patient, one supplying insulin and the other glucagon. The control center in the prototype is a modified iPhone that wirelessly tells the pumps how to respond to shifts in glucose. "It makes adjustments every five minutes, 288 times a day," says Damiano. The components all fit into a fanny pack or coat pocket.

In trials involving two groups of diabetic patients, adults and adolescents, the bionic pancreas provided tighter control of blood glucose than standard measures such as insulin pumps and blood-sugar monitors.

The team's goal is to submit an updated device for FDA review in 2016. Damiano made a bet with himself that a final version of the apparatus would be ready by the time David goes to college. How soon is that? "Thirty-three months," he says. –JEFF WHEELWRIGHT

28

HOW THE BIONIC PANCREAS WORKS



TOP: ELLEN WEBBER. BOTTOM: JAY SMITH

29

Two views of the Laser Weapons System, developed by the U.S. Navy and deployed in the summer on the USS *Ponce*.

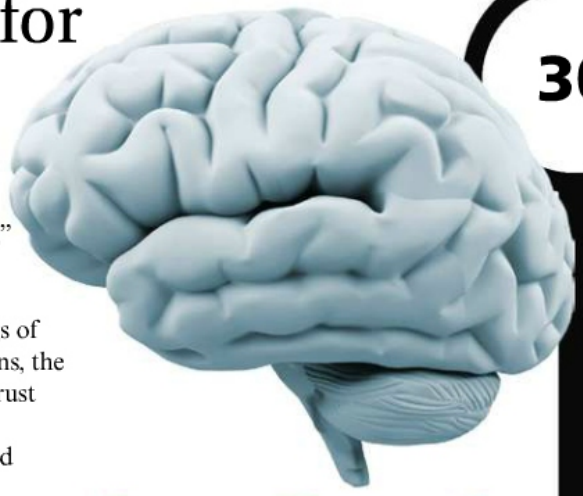
Navy's First Laser Weapon Ships Out

The U.S. Navy turned science fiction into reality over the summer by deploying its first laser beam weapon on the USS *Ponce*, a transport ship. The solid-state Laser Weapons System blasts targets with an energy beam that's concentrated enough to set drones and small enemy boats ablaze. The weapon uses just 30 kilowatts of energy per shot, which means it's also cost effective. (A clothes dryer uses about 3 kilowatts per load.) "You're getting shots for less than a dollar, as opposed to ammunition, which can cost hundreds of dollars per round," says Navy Cmdr. Vince Chernesky. — CARL ENGELKING

LEFT COLUMN: NAVY PHOTOS BY JOHN F. WILLIAMS. RIGHT COLUMN FROM TOP: ANNTI/SHUTTERSTOCK; KYUNG-SUK KIM AND MAZEN DIAB/BROWN UNIVERSITY

30

New Math for Designer Wrinkles

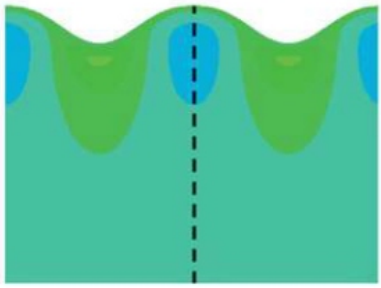


"Folds are everywhere," says Kyung-Suk Kim, an engineer at Brown University. They're in the wings of insects, the surface of our brains, the fabric of umbrellas, even the crust of the Earth.

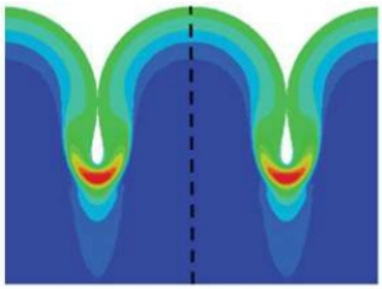
In June, Kim's team reported the first general mathematical description of how the surfaces of common rubbery materials fold. Imagine laying a sheet of paper flat on a table, then squeezing it together from both ends. First, it begins to wrinkle: Little waves form on the surface, with rounded peaks and U-shaped troughs. As you squeeze it more, the wrinkles accumulate, and the U-shaped troughs compress until two tips of each U touch. With still more force, the lower part of each U collapses, forming creases.

By analyzing these states — called "ruga" states from the Latin word for "wrinkle" — Kim and postdoc Mazen Diab developed a series of customizable equations that allows researchers to calculate, from the stiffness of a material, how much it must be compressed to wrinkle, fold or crease. The equations also predict how hard they must pull the sheet to unfurl the material.

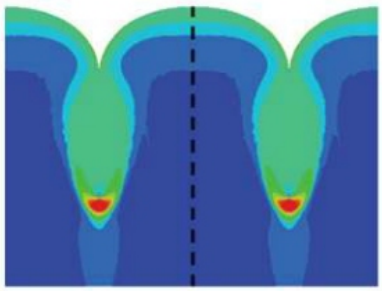
The new equations could shed light on how brain tissue compresses during a head injury, as well as enable a vast array of engineering applications, including creating hairpin-shaped crinkles in thin materials to control liquids on tiny devices; building wearable gadgets that stretch and wrinkle just so; making ultrathin electronics that are resistant to harmful creases; and more. To control folds is to control the critical nooks and crannies of the world. — SHANNON PALUS



WRINKLE



FOLD



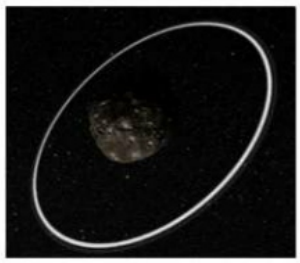
CREASE

Surefire wrinkles: New mathematics lets scientists predict how squeezing a rubbery material causes its surface to deform. First, the surface forms wavelike wrinkles (top), then loose folds (middle) and, finally, tight creases (bottom).

31

Asteroid Rocks the Rings

Rings are common sights around the four largest planets of the solar system, but astronomers reported in March that they had found the celestial circles around an unexpected and much smaller fifth target: an asteroid named (10199) Chariklo. The space rock is just 154 miles wide, yet when it passed in front of a distant star, two delicate, icy rings clearly stood out. One is about 4 miles wide, the other 2 miles, and a 6-mile gap separates them from each other. The illustration above shows Chariklo's surface and the sun behind the rings, which might have arisen from a collision that once rocked the asteroid. —BILL ANDREWS



The asteroid named (10199) Chariklo is the smallest known object to sport a set of rings.

32

Next-Gen Sound Capture Is in the Bag

"Mary Had a Little Lamb" has once again made aural history. More than 130 years after Thomas Edison shouted the song to his tinfoil phonograph, making the first human voice recording, researchers from MIT, Microsoft and Adobe recorded the rhyme using the world's first "visual microphone" — an empty bag of potato chips.

Just as a song's bass thumps in your chest at a concert, Mary's lamb caused minute vibrations — just tenths of a micrometer — in the chip bag. While our eyes can't see the tiny vibrations, the team's high-speed camera, placed behind soundproof glass, could. By analyzing only the bag's tiny shakes, they reproduced the whole rhyme, the scientists announced in August.

Theoretically, with most cameras and this general technique, you could leave Doritos in your friend's room and find out what people are saying about you. Police could one day comb security camera footage and identify a perp by how his voice gonged against a glass of water. But the technique's most valuable application will likely be using sound to probe the structural properties of objects — studying metal alloys, for instance, by blasting sound at them.

By filming the vibrations of a bag of chips, scientists can now re-create ambient sound.

The visual microphone turns the world into an even more data-rich place, ready to be mined, according to lead scientist Abe Davis. "We've shown that video, which is everywhere today, contains all this information that we didn't know was there," he says. "It adds a new dimension to the way we can image the world." —SARAH SCOLES

Visit DiscoverMagazine.com/Microphone to see this tech.

FROM TOP: ESO/L. CALÇADA/M. KORNMESSER/NICK RISINGER/SKYSURVEY.ORG (2); ABE DAVIS, ET AL./MIT

Japan's 'Scientific' Whaling Program Harpooned by U.N. Court

Critics have long argued that Japan's "scientific research" whaling was commercial hunting cloaked in a lab coat. In March, the United Nation's International Court of Justice agreed: It ordered Japan to halt its annual hunt off Antarctica. But the ruling may be only a temporary setback for the Land of the Rising Sun.

The International Whaling Commission imposed a moratorium on commercial whaling in 1986, but it allowed the killing of some whales for scientific research. Since then, Japanese harpooners have caught 10,710 Antarctic minke whales in the Southern Ocean around Antarctica, a whale sanctuary. Japan claimed the kills were necessary to study recovering populations, but the court said they were excessive.

Japanese whalers cut up an Antarctic minke whale, one of 10,710 killed under a 1986 research loophole.

Japan isn't likely to put away its harpoons, though. Japanese officials say they plan to redesign their research program to align with the commission's rules.

"I would bet the farm that whaling will continue in the future much as it has, albeit with some flimsy window dressing to make it look like they're complying with the spirit of the ruling," says whale researcher Phillip Clapham of the National Marine Mammal Laboratory.

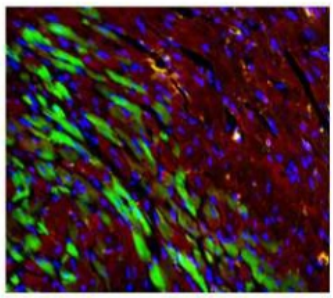
If Japan — the only nation using the loophole — submits an acceptable proposal to the commission, the country could resume the practice as soon as November 2016.

— SUSAN MORAN

This 1993 photo of a crew tying up minke whales during a Japanese "research" expedition helped spark a global outcry and court action.

TOP: PAUL ENSOR/HEDGEHOG HOUSE/MINDEN PICTURES/CORBIS. BOTTOM: MARK VOTIER/HULTON ARCHIVE/GETTY IMAGES

34 Heart Cells Transformed Into Pacemakers



Eugenio Cingolani, left, of the Cedars-Sinai Heart Institute and his colleagues used a gene to spur typical heart cells to become specialized pacemaker cells, shown above in green.

About 700,000 times a year, surgeons slice a pocket into someone's chest, implant a battery-powered device and thread electrical leads into the heart. Such pacemakers allow malfunctioning hearts to beat steadily, keeping patients alive.

But in rare cases, the devices can cause infections when implanted, and batteries don't last forever. What if the body could be coaxed into making new pacemaker cells to replace those destroyed by age, disease or damage?

Researchers took a step in that direction by using a cold virus to deliver a gene into the heart of a living pig. Once there, the gene transformed a few typical heart cells into specialized pacemaker cells. The genetically improved hearts not only beat properly, but the pigs were more active, suggesting that they felt better, too, says Eugenio Cingolani of the Cedars-Sinai Heart Institute in Los Angeles. He and colleagues reported the finding in July in *Science Translational Medicine*.

Such biological pacemakers could eliminate the need for the devices and the leads, which can become infected or damaged, requiring doctors to remove the pacemakers. The special cells also would eliminate additional surgeries for younger adults and children with congenital heart defects, who need new pacemakers as they grow.

Pacemaker cells could eventually help the most vulnerable patients of all: those who haven't yet been born. Now, fetuses with heart rhythm problems have to wait until birth to get a pacemaker — if they live that long. The new technique could offer the potential for treatment in utero. —KAREN WEINTRAUB

35 Prevalent Pesticide Linked to Bird Decline

News flash! Insecticides harm birds, according to a pioneering book published — oh, back in 1962.

Silent Spring was biologist and writer Rachel Carson's call to arms for the nascent environmental movement, and it led to bans on organochlorines like DDT. But, in a case of déjà vu all over again, scientists have now linked some of today's most widely used pesticides — a class called neonicotinoids — to worrisome declines of farmland birds.

Previous studies linking neonicotinoids to sharp declines in honeybee populations, known as colony collapse disorder, prompted the European Union in 2013 to pass a two-year ban on the use of the pesticides, though bee experts now believe a parasitic mite, poor nutrition or both may also weaken or kill the insects.

Farm insecticides may leave young barn swallows without enough food.

The worrisome study of birds, published in July in the journal *Nature*, focused on the effect of imidacloprid, the most popular neonicotinoid, on 15 species. Researchers from Radboud University in the Netherlands found that in the two decades since Dutch farmers began using the pesticide on a variety of crops, the birds' population declined by an average of 3.5 percent annually in farmlands where local water levels contained high concentrations of the chemical.

The researchers theorize that the decline is occurring not because the birds ingest imidacloprid, but because the pesticide wipes out the insects that nine of the 15 bird species rely upon for food.

Although the researchers cautioned that more study is needed, they urged lawmakers in the meantime to "take into account the potential cascading effects of neonicotinoids on ecosystems."

—DAN HURLEY

TOP: CEDARS-SINAI HEART INSTITUTE (2). BOTTOM: MICHAEL DEFREITAS/ROBERT HARDING WORLD IMAGERY/CORBIS

Doctor ***Designed.*** Audiologist ***Tested.*** FDA ***Registered.***

Affordable *New* Digital Hearing Aid *Outperforms* Expensive Competitors Delivers *Crystal -Clear* Natural Sound

Reported by J. Page

Chicago: Board-certified physician Dr. S. Cherukuri has done it once again with his newest invention of a medical grade ALL DIGITAL affordable hearing aid.

This new digital hearing aid is packed with all the features of $3,000 competitors at a mere fraction of the cost. Now, most people with hearing loss are able to enjoy crystal-clear, natural sound—in a crowd, on the phone, in the wind—without suffering through "whistling" and annoying background noise.

After years of extensive research, Dr. Cherukuri has now created a ***state-of-the-art*** digital hearing aid that's packed with the features of those expensive $3,000 competitors – at a ***fraction of the price***.

New Digital Hearing Aid Outperforms Expensive Competitors

This sleek, lightweight, fully programmed hearing aid is the outgrowth of the digital revolution that is changing our world. While demand for "all things digital" caused most prices to plunge (consider DVD players and computers, which originally sold for thousands of dollars and today can be purchased at a fraction of that price), the cost of a digital medical hearing aid remained out of reach.

Dr. Cherukuri knew that many of his patients would benefit but couldn't afford the expense of these new digital hearing aids. Generally they are not covered by Medicare or most private health insurance.

The doctor evaluated all the high priced digital hearing aids on the market, broke them down to their base components, and then created his own affordable version—called the **MD**HearingAid®***AIR*** for its virtually invisible, lightweight appearance.

100% MONEY BACK GUARANTEE 45 DAY RISK FREE TRIAL

Proudly assembled in the USA from Domestic & Imported Components.

BBB RATING A

- ✓ Nearly *invisible*
- ✓ *Crystal-clear* natural sound
- ✓ No suffering with *'whistling'* or background noise
- ✓ *Outperforms* $3,000 models
- ✓ Amazing *low price*

Affordable Digital Technology

Using advanced digital technology, the **MD**HearingAid®***AIR*** automatically adjusts to your listening environment—prioritizing speech and de-emphasizing background noise. Experience all of the sounds you've been missing at a price you can afford. This doctor designed and approved hearing aid comes with a full year's supply of long-life batteries. It delivers crisp, clear sound all day long and the soft flexible ear buds are so comfortable you won't realize you're wearing them.

Try It Yourself At Home With Our 45 Day Risk-Free Trial

Of course, hearing is believing and we invite you to try it for yourself with our RISK-FREE 45-day home trial. If you are not completely satisfied, simply return it within that time period for a full refund of your purchase price.

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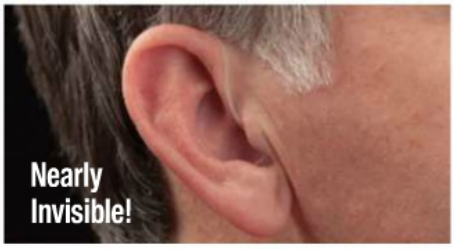
FREE Batteries For A Year!



Ecstatic Users Cheer

"I recently purchased an MDHearingAid AIR for both ears. They are as small and work as well as a $5,000 pair I had previously tried."

— Dennis

"I'm a physician, and this product is just as effective (if not more) than traditional overly-priced hearing aids. I will be recommending (it)."

— Dr. Chang

"As a retired advanced practice nurse, I purchased the MDHearingAid AIR after the Wall Street Journal *review. I am so pleased with the quality. You are providing a real service to our affordable health care."*

— Ned Rubin

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A Pint-Size Polar Predator

36

Nanuqsaurus hoglundi was the big little dinosaur find that nearly got left behind.

Classified in a March study, the hobbit *T. rex*, barely two-thirds the size of its more famous relative, roamed the Arctic some 70 million years ago. It's the only tyrannosaur ever found outside temperate latitudes, rewriting our understanding of the animals' diversity.

"I recall just hoping I'd remember to put those rocks on the helicopter," says Anthony Fiorillo, curator of Earth sciences at the Perot Museum of Nature and Science in Dallas.

In 2006, Fiorillo's team was above the Arctic Circle, on Alaska's North Slope. The polar season for fieldwork is brief, and they were busy excavating horned dinosaurs. But they also noticed a few interesting-looking, basketball-size rocks lying around the site. Fiorillo set them aside, thinking he would take them if the helicopter had room. It did.

Paleontologist Ron Tykoski looked at the rocks when they arrived at the Perot a few months later with 11,000 pounds of other material from the Alaskan dig. "I realized, hey, that's a skull with sharp, pointy teeth. That's a predator," says Tykoski.

But he was focused on the 4-ton horned dinosaur *Pachyrhinosaurus perotorum*. After a cursory examination, he decided the predator was probably closely related to *Albertosaurus*, a bipedal carnivore, and he set the rocks aside.

Yet as the researchers continued working, they noticed something. "We were finding isolated teeth with the horned dinosaur bones, even scoring on the bones, and started wondering, 'Who's eating our horned dinosaur?'" says Fiorillo.

The team took another look at those basketball-size rocks. The teeth found in the rocks were consistent with those that had once sunk into *P. perotorum*. Inspecting the fragments of skull, jaw and teeth more closely, they realized they had a tyrant on their hands.

Although short stuff compared with *T. rex, N. hoglundi* was still formidable, about 25 feet from teeth to tail. Its shrunken size may have been an adaptation to survive the long polar winter, when months of near or total darkness meant limited hunting opportunities.

—GEMMA TARLACH

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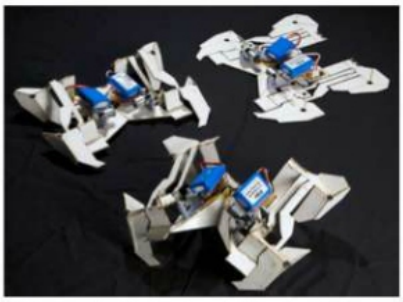
Origami Robots Enter the Fold



Using embedded wires to heat and shrink its initially flat body, the self-folding robot is ready to scuttle away in just minutes.

At first glance, it looks like a child's science fair project: a flat, plastic cutout with batteries in the middle. Then it shudders to life. A few joints bend. The midsection rises with a startling jolt. Moments later, it scuttles away.

This crab-walker — which self-assembles from about $20 worth of parts and walks without human direction — marks an advance in inexpensive and versatile robotics that could ultimately be created for pennies, stacked like a deck of cards and deployed in spaces and applications where no robot has gone before.

The robot, created by researchers at Harvard and MIT who published their work in *Science* in August, is made of paper and 3-D sheets of polystyrene from the children's art toy Shrinky Dinks. Embedded wires heat and shrink the material in certain places, allowing the robot to fold like a piece of origami or unfurl like a flower petal.

Researchers envision using such robots in places where humans can't easily go — a ream of sheets sent into space could unfold into a satellite, for example. They also could revolutionize manufacturing and allow people to design and print their own robot to do whatever they want, even play games with their cat, suggests Daniela Rus, director of the Computer Science and Artificial Intelligence Laboratory at MIT and one of the lead scientists on the project. "This would really democratize robots," she says.

—KAREN WEINTRAUB

See the robot in action at DiscoverMagazine.com/Robot

TOP: KAREN CARR. BOTTOM: SETH KROLLWYSS INSTITUTE

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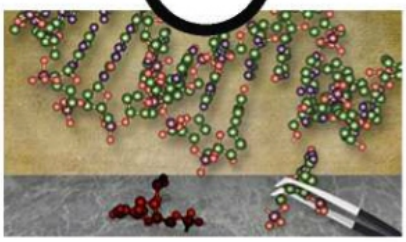

A Giant Step for Gene Surgery

Just two years ago, Jennifer Doudna of the University of California, Berkeley, commandeered a process that bacteria use to fend off viruses, creating a molecular scalpel to snip out defective genes. The finding launched a genetic engineering gold rush, and since then, researchers have raced to use the new method, called CRISPR, to treat — and perhaps even cure — genetic diseases.

In March, Daniel Anderson's team at MIT moved out in front in that race by using CRISPR to repair a faulty gene in adult animals. The researchers corrected a mutation in liver cells in mice by snipping out the gene and sewing in a healthy copy of it. This cured the mice of the hereditary disease tyrosinemia, which causes the amino acid tyrosine to accumulate and can lead to liver failure.

The method repaired the gene in just one in 250 mouse liver cells, but those cells replicated enough to break down tyrosine and cure the disorder. Anderson and others are already exploring new gene-delivery methods, including nanoparticles, to better deliver gene-editing therapies to target tissues.

"If we want to treat the greatest number of diseases, we need to figure out how to get these molecules inside the cells of patients — not just increasing the number of target cells but also hitting tissues other than the liver," says Anderson, who co-founded a company called CRISPR Therapeutics to pursue those goals. The method could one day help treat human diseases, including Huntington's, hemophilia and sickle cell anemia.

"It's very exciting because it means we now have a technology that enables rewriting of the genome," Doudna says. — KARI LYDERSEN

CLOCKWISE FROM TOP: CHRISTINE DANILOFF/MIT; SIMON KATTENHOR AND LOUISE PROCKTER/NASA/JPL-CALTECH (2)

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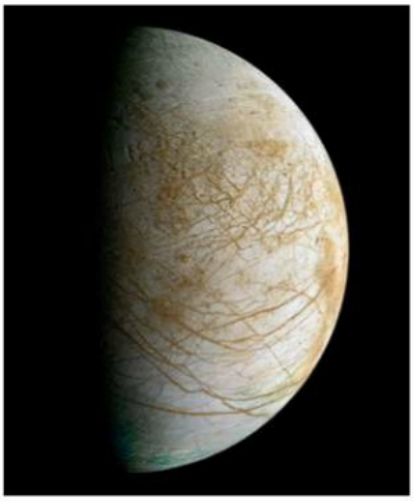
Europa's Icy Jigsaw Puzzle Solved

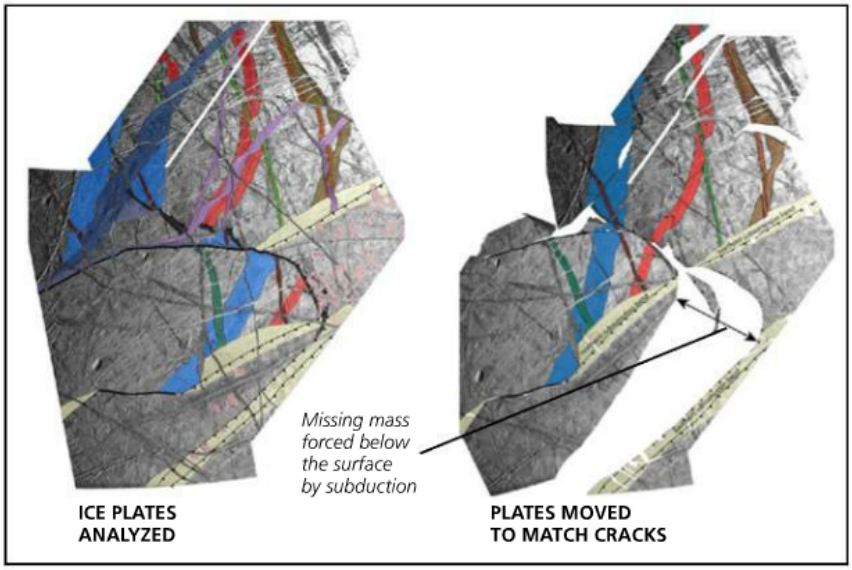
Ever since NASA's two Voyager spacecraft snapped the first photos of icy cracks crisscrossing Jupiter's moon Europa in 1979, astronomers have speculated that tectonic forces could be at work. But the first solid evidence didn't arrive until September, when a team of planetary geologists announced it might have solved the mystery by treating the moon's crust like a jigsaw puzzle.

Using data from the '90s-era Galileo probe, the team — led by Simon Kattenhorn, a structural geologist and planetary scientist at the University of Idaho — digitally deconstructed one region of the moon's surface into icy pieces, then tried to fit them back together. Researchers were surprised to find a 7,700-square-mile piece (about the size of Wales) missing, but they theorized that it had moved over warmer ice layers until it collided with another plate and was forced beneath the surface, out of view. (This process, called subduction, creates mountain ranges, volcanoes and trenches on Earth.) NASA officials say it's the first evidence that a body other than Earth has active plate tectonics.

The find isn't just geologically interesting: The movement of material from the inhospitable surface down into the ocean could supply crucial chemical nutrients for possible living organisms in the global ocean far below. — ERIC BETZ

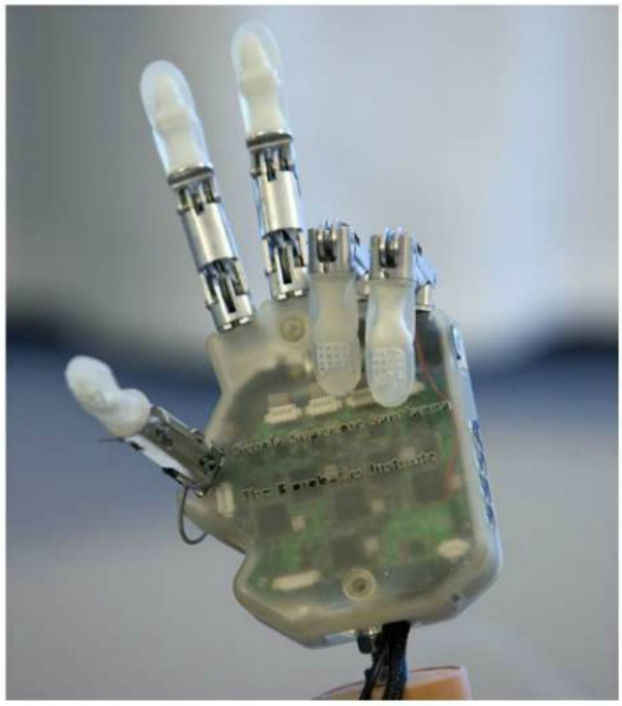


Jupiter's moon Europa, at right, has fascinated astronomers with its intricate and colorful cracks. Astronomers assembling the "puzzle pieces" of its icy surface discovered a large missing piece.



A Sensitive Advance in Prosthetics

40



(Clockwise from left) Danish amputee Dennis Aabo Sørenson was able to distinguish between similar objects and even identify a majority of objects in blind tests. The hand sends signals via sensors in the hand's "tendons" to nerves in the patient's arm.

The road to a major breakthrough in prosthetics began decades ago with a young Italian boy in front of a TV.

"I watched *The Six Million Dollar Man*, fascinated by the idea of connecting the natural and the artificial and using this technology to help people," says Silvestro Micera, now the lead researcher of the European LifeHand 2 project.

In February, Micera and his colleagues announced that they had successfully tested the first artificial hand to provide its user with real-time sensory feedback that can be used to modulate grasping force.

The bionic hand creates sensation by sending signals from sensors embedded in the artificial hand's "tendons" to electrodes implanted in the remaining nerves of the wearer's arm. The signals are precise enough that the wearer can distinguish between objects of similar shape but different stiffness, such as an orange and a baseball.

The team's next step will be to make the prosthetic more portable; it's currently connected to a control box. Micera notes other researchers are pursuing similar technologies, and he expects real-time sensory prosthetics to be available to amputees within a decade.

"This was simply the end of a story that started 20 years ago," says Micera. "In principle, we showed this could work. At the very end, whether I bring it to clinical practice or my competitors do, I know it will work." – GEMMA TARLACH

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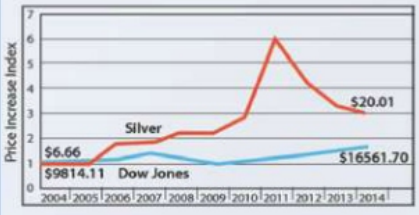

INVESTMENT

Increasing prices of precious metals make every Morgan Silver Dollar more valuable. But acquiring your own private cache of Morgan Silver Dollars is a long term investment in so much more... in history... in American heritage... in the splendid rendering of Miss Liberty's profile by designer George T. Morgan, whose "M" mark on every Morgan Silver Dollar identifies his masterwork. And, of course, Morgan Silver Dollars have not been minted for 94 years and are no longer in circulation.

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A message from the

37TH TREASURER OF THE UNITED STATES

Hello, I'm Angela Marie Buchanan. You might know me as Bay Buchanan. I was appointed by Ronald Reagan to be the 37th Treasurer of the United States… maybe you've seen my signature on some of the bills in your wallet. So, you can understand why our nation's coins are vitally important to me. That's why I'm so pleased to be able to announce this release of Morgan Silver Dollars by National Collector's Mint.

Of all the coins ever struck by the U.S. Gov't, none have so captured our imaginations the way Morgans have. I invite you to sample some of these magnificent Morgan Silver Dollars. Enjoy them. Protect them. Celebrate them. What better way to hold your history, our history, America's history in the palm of your hand!

Sincerely,

Angela Marie (Bay) Buchanan
37th Treasurer of the United States of America
Co-Director, NCM Board of Advisors

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Archaeologists Explore Largest-Ever Greek Tomb

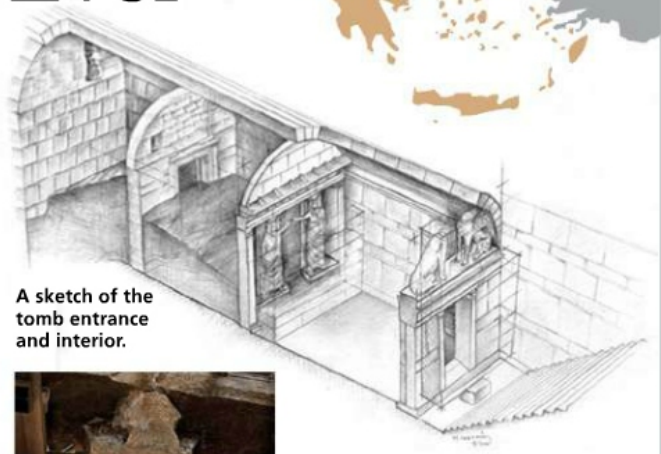
Large stone sphinxes, women sculpted in marble, intricate mosaics and multicolored frescoes awaited archaeologists in August when they entered the largest tomb ever found in Greece.

The scale of the tomb, which dates to the fourth century B.C., suggests it may belong to Roxane, wife of Alexander the Great, or their son, also called Alexander. Both were killed by political rivals after the death of the Macedonian conqueror in 323 B.C.

The burial complex, which doesn't appear to be looted, was found outside the ancient Macedonian city of Amphipolis in 2012, but its entrance wasn't located until August.

Throughout autumn, stunning new finds emerged almost daily, including a large floor mosaic depicting Pluto's abduction of Persephone.

The dig has not been without controversy. Greek Prime Minister Antonis Samaras pre-empted the archaeologists in announcing the discovery. Groups such as the Association of Greek Archaeologists have complained that the subsequent relentless media coverage, floods of tourists and increased risk of looting are compromising ongoing work at the site. – GEMMA TARLACH



A sketch of the tomb entrance and interior.

One of two caryatids (left), sculpted female columns, guards the second chamber. A mosaic (above) on the floor of that chamber depicts Pluto's abduction of Persephone. Two sphinxes (below) stand above the tomb's entrance. One of the heads was found in October.

A 500-meter-long, 3-meter-tall limestone and marble wall circles the massive tomb, seen above in a satellite view.

See more photos of the tomb, including details of the artifacts within, at DiscoverMagazine.com/Tomb

CLOCKWISE FROM TOP: ROEN KELLY/DISCOVER; HCMPOLARIS (4); ALEXANDROS MICHAILIDIS/AP PHOTO/CORBIS; GOOGLE EARTH

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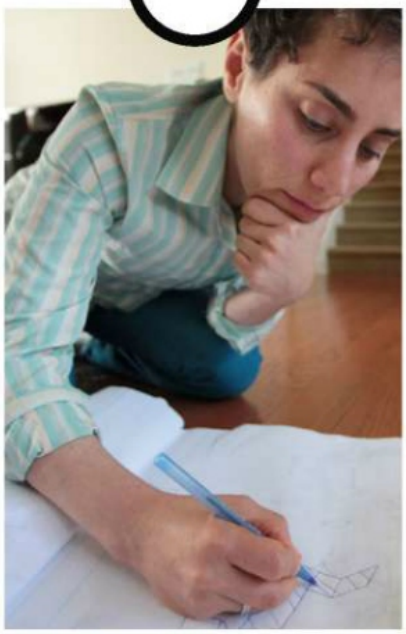

Fields Medal recipient Maryam Mirzakhani sketches out a geometry problem.

Fields Day

At 37, Maryam Mirzakhani has become the first woman to be awarded the Fields Medal, often considered the highest honor in mathematics. Born in Tehran, Iran, Mirzakhani came to the U.S. to attend graduate school at Harvard. There, she began to research hyperbolic surfaces, geometric objects that can be visualized as having a saddle shape at every point. Later, she made an enormous breakthrough in understanding the trajectories that balls would trace if they bounced forever around a billiard table of nearly any shape. "This is amazing, formidable work," says Etienne Ghys, a member of the Fields Medal committee. "Sometimes mathematics is easy and fun and a pleasure, and sometimes you have to suffer for it. This took suffering." – JULIE REHMEYER

The Fields Medal is awarded every four years by the International Congress of Mathematicians.

FROM LEFT: THOMAS LIN/QUANTA MAGAZINE; STEFAN ZACHOW/INTERNATIONAL MATHEMATICAL UNION; JAY SMITH, AFTER SYNTHORX

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First Organism With Artificial DNA Debuts

A chimera, in Greek mythology, is a creature made from parts of different animals — an alien monster. That's how some might view the organism created by a team at Scripps Research Institute in California.

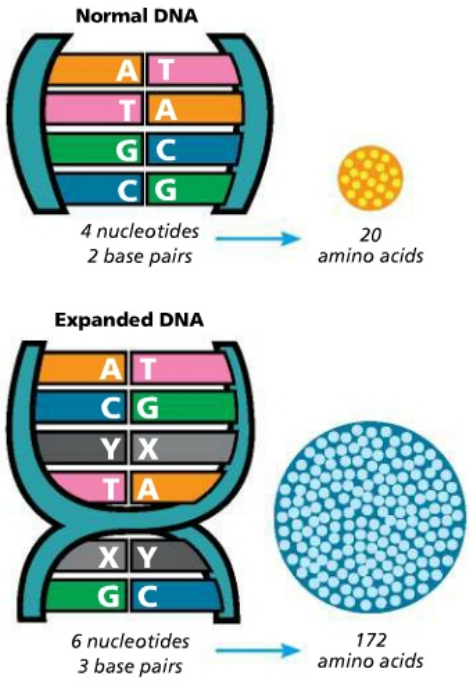
Expanding upon DNA's complement of four chemical nucleotides, or "letters" (A, T, C and G), the scientists concocted a totally unnatural pair of nucleotides, dubbed X and Y. As reported in *Nature* in May, the team inserted the two into a bacterial cell, a strain of *E. coli*. When the cell reproduced, unwinding its double helix and reconstituting it in new cells, X and Y replicated as well, their chemical bond just as stable as the A-T and C-G pairings in DNA's normal sequence.

The leader of the Scripps team, Floyd Romesberg, calls the organism "semi-synthetic." He promises it could never survive outside the lab because the foreign nucleotides, deprived of their chemical feedstock, would quickly be deleted. "We are focused on what's practical," he says. "We're not trying to create new life, but to increase proteins' potential. … With more [DNA] letters, you can tell more interesting stories."

DNA encodes amino acids, which are the building blocks of proteins. These proteins, in turn, are the building blocks of life. DNA's four nucleotides have enabled 20 amino acids. By adding just one more pair of letters, chemists could potentially have 172 amino acids to work with, and a limitless number of new proteins.

Pharmaceutical companies increasingly look to proteins as templates for new drugs. However, protein molecules are much larger than most drug molecules, and synthesizing them is a "laborious, one-at-a-time" process, says Romesberg. "It's a huge advantage that the cell does the heavy lifting for you."

Cell factories, their DNA tweaked by different combinations of nucleotides, may one day generate therapeutic proteins that could be tested against each other in cultures. Romesberg calls this "directed evolution — you apply selection pressure to the cells, and you [keep] those that do what you want the best." – JEFF WHEELWRIGHT



Normal DNA is made up of the nucleotides adenine, thymine, cytosine and guanine. Adding just one more pair of "letters" — X and Y — to the genetic alphabet opens the door to 172 amino acids, which could be used to build new proteins.