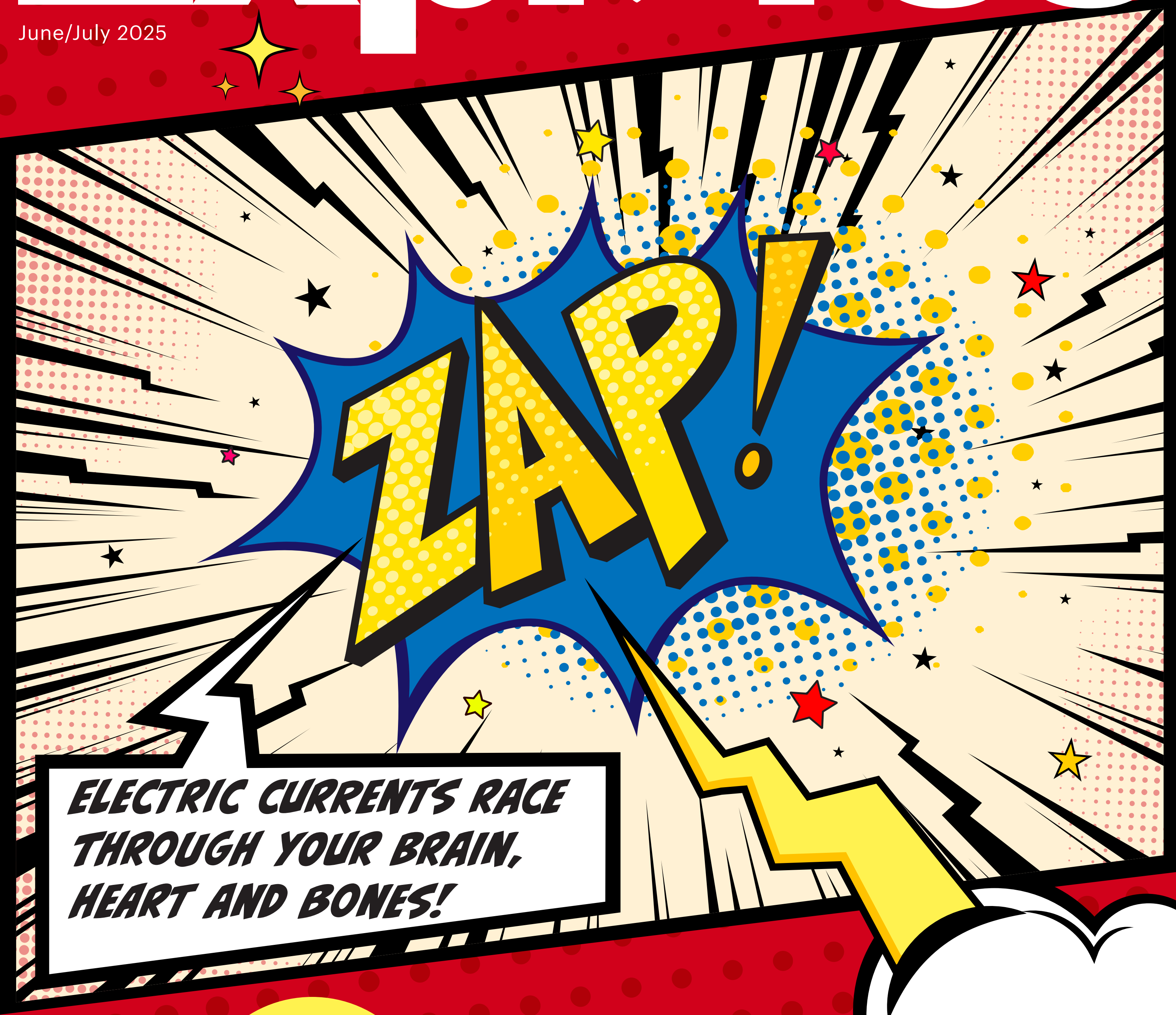
Science News

Explores

June/July 2025



ANATOMY OF A HEARTBEAT

P28

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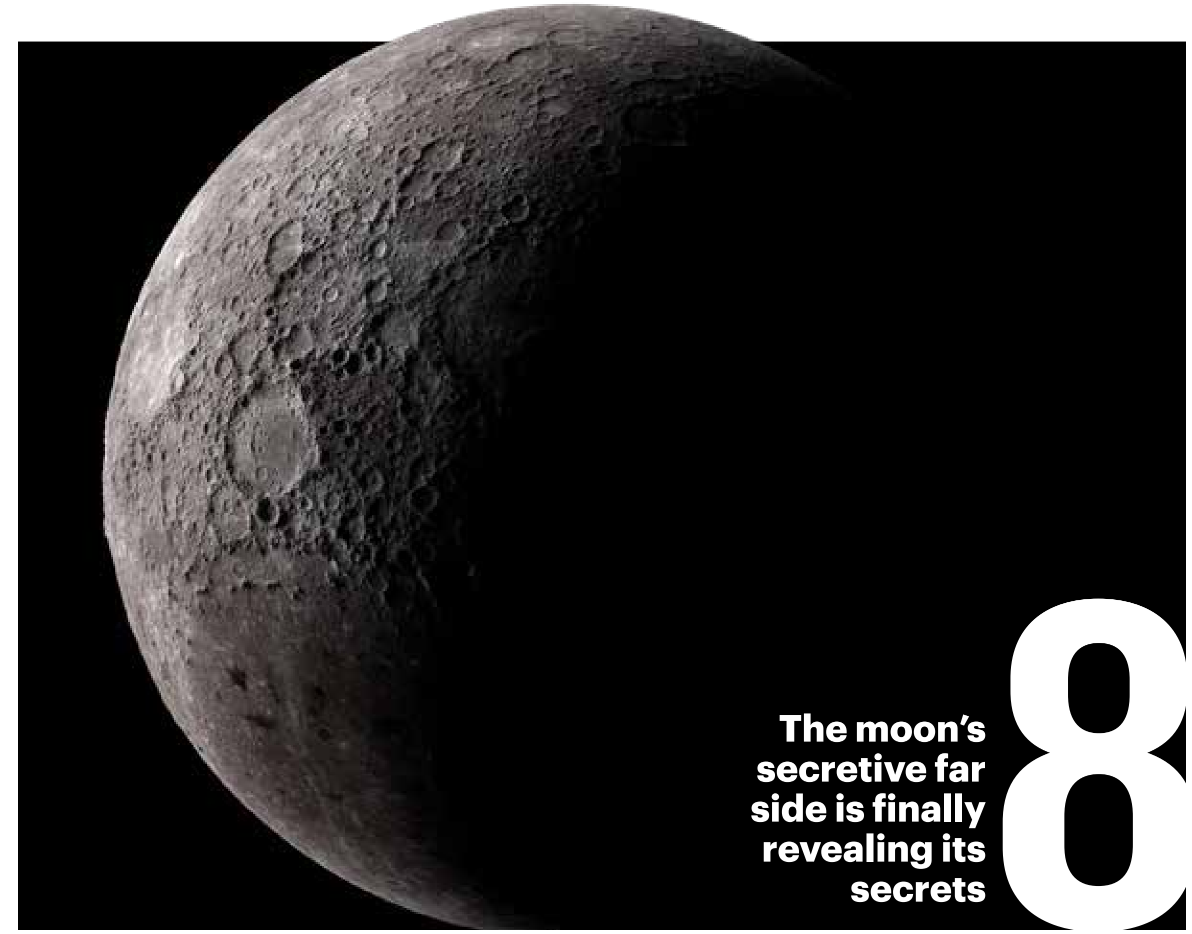

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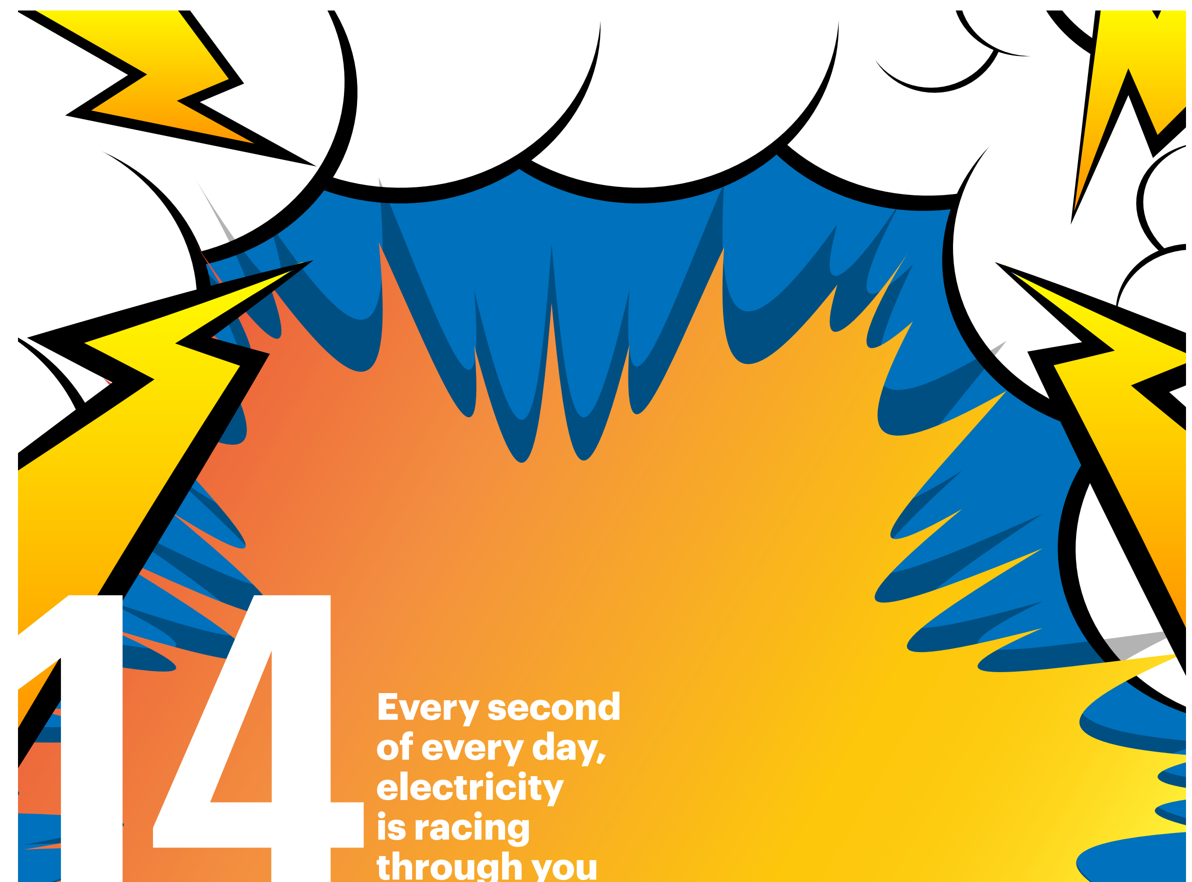

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MCKINNA THOMAS/SHUTTERSTOCK

Q Why do we see steam, since it's a gas? Also clouds.

— *Jeremy F.*

A Steam and clouds are not actually gases — but they are made from gases. They're plumes of water droplets floating in the air. But steam and clouds both arise from the gaseous form of H_2O, or water vapor, which is invisible. Let's look at steam first. Say you are boiling a pot of water on the stove. Some of that water will evaporate and enter the air as gaseous H_2O molecules. As that humid air drifts away from the pot, it cools enough for some of the H_2O gas in the air to condense into tiny water droplets. Those droplets are visible as steam. As this steam spreads out into drier air, its water droplets evaporate again, and the steam disappears. Similarly, clouds form when water vapor in the atmosphere condenses into tiny liquid droplets or even tiny bits of ice. Steam and clouds both look white because of the way light scatters off their droplets.

Q How does dust form?

— *Taylor R.*

A Nearly every solid substance can be broken down into the tiny, airborne particles that make up dust. In some places, strong winds can lift particles from dry soil into massive dust storms. But dust isn't only found outdoors. Outside materials — including dirt, ash and pollen — can find their way into our homes and add to the dust you might see around the house. This dust also often includes shed skin cells and hair, worn-down clothing fibers, insect parts and bits of plastic. These tiny particles eventually mix and settle on surfaces. Such dust isn't just an eyesore. It provides the perfect home for house dust mites. These microscopic critters forage for skin cells and mold. While the mites won't harm you, some people can become allergic to the poop, casings and fluids they leave behind.

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Sarah Zielinski
Editor, Science News Explores

PLANTS

Trees absorb planet-warming methane gas

These climate heroes were already known to take in carbon dioxide

Trees are important for the health of our planet. They pull carbon dioxide, a planet-warming gas, out of the air. They also take up methane, scientists have now learned. Methane is an even more potent greenhouse gas than CO_2. This means that to slow climate change, protecting forests is more important than ever.

Much of the methane in air comes from human activities. These include agriculture, landfills and burning fossil fuels. But methane also has natural sources, such as microbes in wetland soils. Trees, too, were known to release methane, especially those growing in wet soils. They take up the gas from soil and emit it through their trunks.

Vincent Gauci studies methane emission from trees. He's an environmental scientist at the University of Birmingham in England. Gauci expected trees in drier soil would give off some methane, but less than those at wetter sites.

That's not what he found.

"We were surprised to see the exact opposite," says Gauci. The trees were actually taking in methane. Think of how many trees there are on the planet, he notes. That could add up to a lot of methane being removed from the air.

When trees take in or release gases — such as carbon dioxide and oxygen — it's called gas exchange. Researchers typically measure methane exchange low on the trunk, near the ground. That's because methane comes into the tree from the roots and is quickly released from the trunk.

But Gauci's team took their measurements higher up on the tree. They thought this would better estimate how much methane the whole tree might emit. They expected methane emissions would drop as they measured higher up the trunk. And that at some point methane release should drop to zero.

Their hypothesis at first seemed to hold. Higher up the trunk, methane release dipped. But about one meter (three feet) off the ground, the numbers dropped below zero. Here, trees were absorbing methane.

The team looked at trees from four regions: 100 trees in Brazil, 18 in Sweden and 24 in each of Panama and the United Kingdom. On average, the trees at all sites took up more methane than they released. Gauci's team shared its findings in *Nature*.

The scientists believe methane is taken in by microbes that live in tree bark. These microbes consume methane and convert it to carbon dioxide. Microbes metabolize faster in warm temperatures. So they take in methane faster in the tropics.

This research is important and eye-opening, says Kazuhiko Terazawa, a forest ecologist. He studies trees and methane at the Hokkaido Research Organization in Japan. If correct, he says, this means the land absorbs nearly twice as much methane as people had thought it did.

Terazawa adds that human activities release far more methane than what nature can remove. So we still have to reduce these emissions and cut back on fossil fuels.

"Trees are even more important for climate than we thought," Gauci says. "We have to protect our forests."

— Laura Allen

By measuring gas exchange in the air around tree trunks (inset), researchers discovered that trees around the world soak in methane, a planet-warming gas.

LARA RED/SHUTTERSTOCK; V. GAUCI

PHYSICS

The gravity-defying physics behind hula-hooping robots

The research provides tips and tricks for using the ring-shaped toys

Spinning, hoop-slinging robots are revealing the physics of a favorite toy — the Hula-Hoop. Scientists found that those robots had to have a particular shape in order to hula-hoop. And that helped explain how the hoops stay up against gravity.

The robots were designed to move in small circles, similar to a person hula-hooping. One shaped like a cylinder couldn't keep its rotating hoop from sliding down. Another robot was shaped like an upside-down ice cream cone. But its hoop would rise up or fall to the ground.

Only robots with indented middles, like an hourglass, could keep the hoops in place. The slope at the bottom of the indent provides an upward force to the hoop as it swings around. That's what helps counteract gravity. And the curvature of that shape kept the spinning ring from drifting up or down and sliding off.

Researchers shared their new findings in *Proceedings of the National Academy of Sciences*.

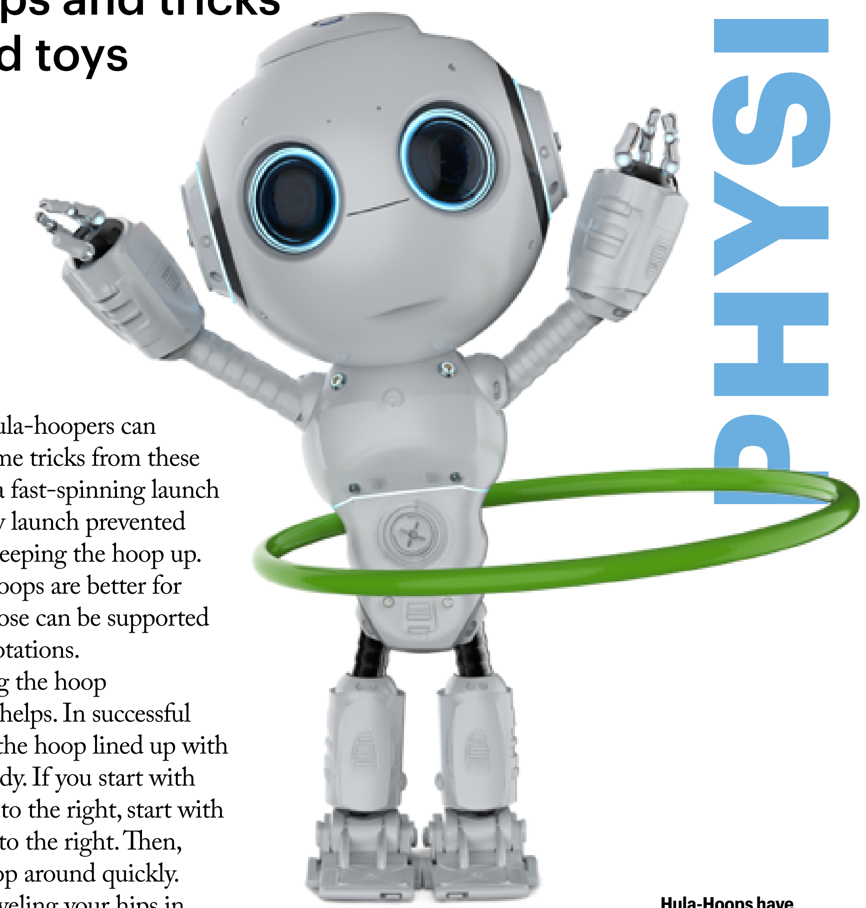
Human hula-hoopers can even learn some tricks from these robots. First, a fast-spinning launch is best. A slow launch prevented robots from keeping the hoop up. And bigger hoops are better for beginners. Those can be supported with slower rotations.

Positioning the hoop correctly also helps. In successful experiments, the hoop lined up with the robot's body. If you start with your hips out to the right, start with the hoop out to the right. Then, swing the hoop around quickly. And start swiveling your hips in that same direction.

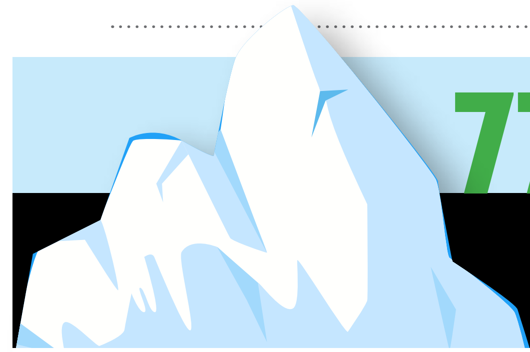
It is important to adapt movements based on the hoop's position, too. The researchers got the cone-shaped robot to successfully hula-hoop by adjusting its rate of wiggling, depending on how high the hoop slid.

With enough practice, people should be able to keep a Hula-Hoop spinning, regardless of body shape.

— Emily Conover



Hula-Hoops have been popular since the 1950s. New experiments with wiggling robots reveal how the hoops stay up — and offer tips for hopeful hula-hooping humans.



770,000 YEARS OLD

The minimum age of the world's oldest glacier, a buried piece of ice in Canada's Nunavut Territory that could be up to **2.8 million years old**.

SOURCE: S. COULOMBE *ET AL*/*GEOLOGY* 2025

PHONLAMAI PHOTO, TARTILA/SHUTTERSTOCK

ANIMALS

KUMAMOTO SANCTUARY

Peeing is contagious among chimpanzees

The reason why remains a mystery

Hate waiting in line for the bathroom? Chimpanzees have a social solution: Everyone goes at once.

A new study shows that among chimps, peeing is contagious. It's the first investigation of contagious urination in animals. Researchers shared the findings in *Current Biology*.

Ena Onishi first got an inkling of this contagious tinkling. She studies animal behavior at Kyoto University in Japan. While watching a group of captive chimps, she says, "I noticed a tendency for [them] to urinate at the same time." Onishi wondered if peeing — like yawning and grooming — is contagious in these animals.

To find out, she and some coworkers spent more than 600 hours studying 20 captive chimps. These animals lived at the Kumamoto Sanctuary in Japan.

The chimps were likely to pee together, the observations revealed. And if one chimp was near another that was peeing, it was more likely to start.

Peeing was contagious among both chimps that knew each other well and ones that didn't. That was a surprise. It's different from the species' copycat grooming and yawning. In those cases, chimps that are socially closer are more likely to mimic such a behavior.

Contagious peeing instead was related to rank. Low-ranking chimps were more likely than others to start peeing if a nearby chimp did. "This was an unexpected and fascinating result," Onishi says. It might happen for different reasons.

High-ranking chimps might influence the urination of others, she says. Or low-ranking chimps may just be more aware of others in social settings. As a result, they may be more likely to respond to others' behaviors. That just might happen to include peeing.

Onishi next wants to study other groups of chimps, including wild ones. That may reveal how factors like sex and age may play a role in this behavior, she says. Scientists could also see if other species, such as bonobos, show such contagious urination.

— *Gennaro Tomma*

When one chimp starts peeing, others tend to follow. It's not yet clear if such contagious urination is useful to chimps in some way.

Think you know what you're seeing? Find out on page 32

CELESTIAL SIDEKICK

Our moon has new tales to share, some from its secretive far side >>

By **Liz Kruesi**

The moon has been Earth's constant companion for billions of years. Scientists are hard at work studying its familiar near side — and recently, its mysterious far side (seen here) — to better understand both how this orb formed and how Earth has evolved over the eons.

ARIZONA STATE UNIVERSITY/GSFC/NASA

The moon is Earth's longtime companion. A bright full moon can light a path through the dark of night. It's long been important for navigation and marking the passage of time. Many civilizations and cultures have used lunar calendars. The dates of some holidays are even set based on the moon's cycle. Visible from everywhere on Earth, the moon has inspired countless bedtime stories, poems, paintings and other forms of art.

"It's one of the few things that unites everybody on this planet," says Noah Petro. A planetary scientist, he works at NASA's Goddard Space Flight Center in Greenbelt, Md.

But we Earthlings only ever see half of the moon. Earth's gravity locks our celestial companion in such a way that the same side always faces us. The other half — the so-called far side — looks different. And scientists have only just begun to learn what it's like.

Over the past half century, scientists have studied hundreds of pounds of lunar chunks. Almost all were retrieved from the moon's near side. In June 2024, though, a Chinese spacecraft brought back rocks and soil from the far side. They represent the first hands-on exploration of our companion's unseen side — and will soon reveal how different the near and far sides are.

Those pieces can also help put together a timeline of the moon's evolution. Its stories, in turn, can tell us about the events that shaped our own planet, says Yuqi Qian. He's a planetary scientist at the University of Hong Kong, in China.

Indeed, he explains, "I study the moon because the moon can tell you about the Earth."

How the moon formed

In the beginning, our solar system was just a disk of gas and dust orbiting a baby sun.

By some 4.6 billion years ago, that gas and dust had begun to glom together. This formed larger pieces. For the next several hundred million years, the resulting space rocks smashed, merged and grew. The young solar system was like a cosmic game of dodgeball.

Then, "over time, the impacts become less and less," says Miki Nakajima. Why? These pebble-formed planets, she notes, had already eaten up the neighboring rocks. Nakajima works at the University of Rochester in New York, where she studies how planets form.

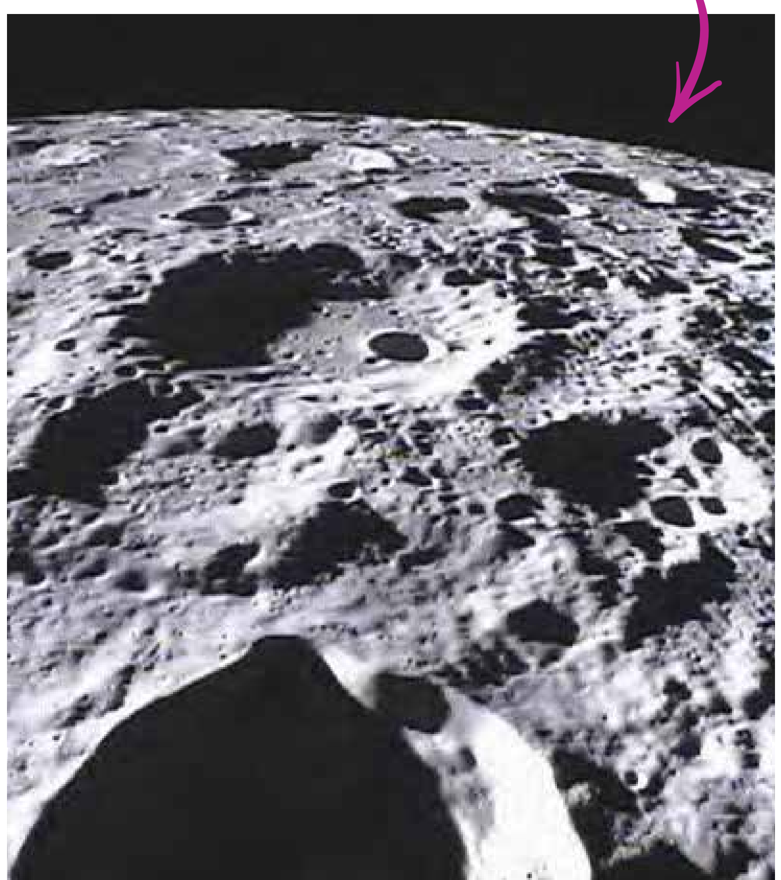
At some point during these cosmic collisions, a protoplanet likely slammed into the young, developing Earth. Such a smash would have been powerful enough to break apart the colliding orb. It also may have knocked loose some matter from the young Earth and sent it into space. All that floating debris could have mixed before glomming back together.

Most scientists agree such an impact happened. Details of what happened next are less clear.

Studies show that certain types of chemical elements in moon rocks match those on Earth. To Nakajima and others, this suggests Earth and its moon come from the same source. Whatever formed the moon left its mark on Earth.

Perhaps the impact spewed material from the young Earth into space, where the debris mixed with the colliding object and formed the moon. Or maybe the energy from that smashup vaporized both the impactor and the top layers of Earth into small particles. These might then have mixed in space, some material becoming our moon and the rest falling back to Earth's surface.

This image came from a now-ended program that let students take pictures of the moon's surface.



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ERNIE T. WRIGHT/SVS/NASA

This heavily cratered site (left) was photographed by the MoonKAM onboard NASA's Ebb spacecraft. It shows Crater Poinsot on the moon's northern far side. Not visible from Earth, this side looks quite different from the facing side we can see.

Some of the mixed debris may still be stuck below Earth's surface, according to a 2023 study in *Nature*. Seismic images show blobs of material under the Atlantic Ocean that could be leftovers of that protoplanet.

By about 3.8 billion years ago, things settled down. Since then, our solar system has looked much as it does today, with eight major planets orbiting the sun.

One of them is Earth, with its natural satellite.

History, recorded

The moon has been right by Earth's side since it formed. That means what happened to the early Earth also happened to the moon. Each faced similar rates of hits from space rocks. Each was bombarded by the same number of flares and other energetic events from the sun.

Over time, though, Earth's surface has changed a lot. On our planet, continents have shifted and morphed over millions of years. Erupting volcanoes oozed rock-forming lava. Rain and rivers washed away layers of rock and carved canyons.

Those changes "here on Earth that make it really great to live [on]," says Kelsey Young, are "not so great for the rock record." She's a planetary scientist at the Goddard Space Flight Center. Newer changes erase or overwrite past details.

Lucky for us, the moon has recorded much of that lost history. So by understanding the lunar surface — through stories told by moon rocks — scientists can learn more about Earth's history. They also can learn about the early solar system. Piecing it together, explains Petro, is "kind of like detective work."

Marked by collisions and volcanism

Pockmarking the gray lunar surface are millions of craters and basins. Scientists have cataloged ones that range from a few meters (yards) across to 2,500 kilometers (1,550 miles) wide. Most of the rocks that made those craters likely slammed into the moon during that giant game of cosmic dodgeball more than 3.8 billion years ago. The newest craters are layered on top of older ones.

Dark patches also cover the side of the moon locked toward Earth. Scientists think the dark basins mark ancient lava eruptions. Molten rock once oozed through surface cracks made by incoming space rocks. Later, that lava solidified. That rock, like volcanic rock here on Earth, is basalt. It appears a very dark gray.

The far side, though, looks "very different," says Qian. It's a lighter gray color with fewer giant dark patches of lava. He's among the scientists working to understand why the hemispheres look so different.

One idea, he says, relates to a time shortly after the moon formed. He and many other scientists think the young moon's surface was still liquid rock — an ocean of magma. Maybe the far side crystallized, or became solid, before the near side, he says. If it did, the crust might also be thicker there.

Later, he says, magma might not have been able to reach the surface and ooze through as easily as on the near side.

To test this idea and others, scientists would need to run experiments on materials up close. But everything that astronauts and robotic rovers have collected had come from just the moon's near side — until last year.

Sampling the moon

On June 25, 2024, the Chinese spacecraft Chang'e-6 returned to Earth with a treasure — 1,935.3 grams (almost 4.3 pounds) of moon rocks and soil. What made this loot extra special was its source: a never-before explored part of the moon.

Chang'e-6 had spent a few days in the Apollo basin on the moon's far side. That site is near the inner edge of the enormous South Pole-Aitken Basin. At about 2,500 kilometers (1,550 miles) across, that's the biggest impact crater on the moon. It spans almost one-quarter of the moon.

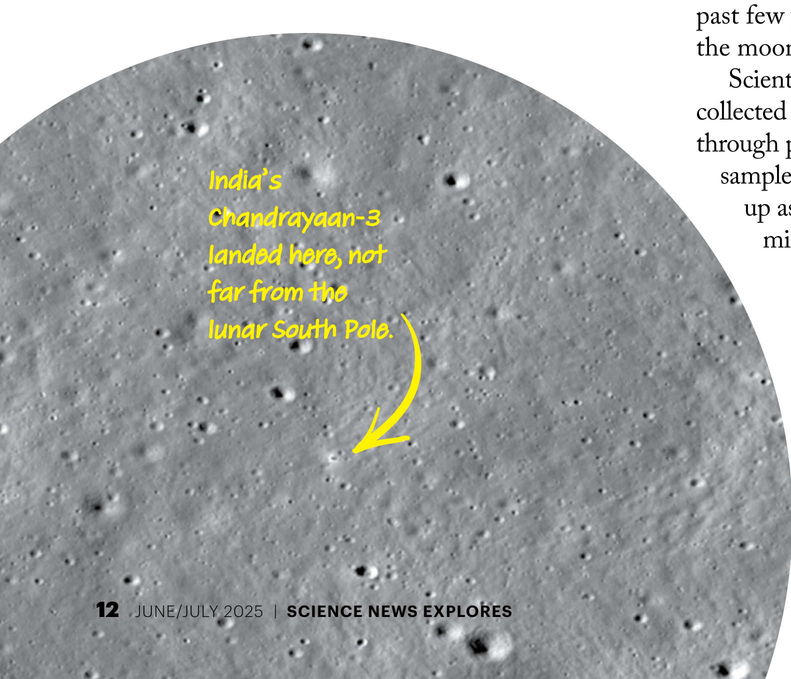
Scientists have mapped other craters layered atop South Pole-Aitken Basin. Based on these, the basin appears to have formed about 4.2 billion years ago. That would make it one of the moon's oldest features. "That basin is special," notes Qian, "because it's ancient."

In fact, this crater helps scientists know when the solar system's dodgeball game started. The samples Chang'e-6 brought back can tell scientists something about that timing and the impact-rich years that followed. By studying these pieces up close in the lab, they have begun to measure ages of the rocks.

In November, they announced the first of likely many discoveries. The scientists say the sampled spot on the moon's far side was liquid magma until about 2.8 billion years ago.

"It's ongoing research," Qian says. He and his colleagues are now learning what those rocks have to say.

Glass beads found on the moon can help scientists learn lunar history.



India's Chandrayaan-3 landed here, not far from the lunar South Pole.

Magma and the moon

These samples — plus another soil-and-rock haul and observations from other spacecraft in the past few years — are also helping to unravel how the moon evolved.

Scientists have been comparing Chang'e-6's newly collected rocks to soil and other rocks collected through previous missions. Those include older samples from the 1960s and 1970s that were picked up as part of NASA's Apollo program and robotic missions by the Soviet Union.

They also include samples collected in 2020 by another Chinese spacecraft, Chang'e-5. That mission brought back rocks and soil from a large lava-filled basin on the moon's near side.

Before looking at those samples, researchers had doubted the moon had liquid magma more recently than about 3 billion years ago. They thought the lunar interior would have been too cold for any hot magma to ooze out. But some locations on the moon appears to have been active far more recently — just over a hundred million years ago.

That's based on a September 2024 report on Chang'e-5's samples. Li Qiuli, a geochemist at the Chinese Academy of Sciences in Beijing, and his team led that study. The chemistry of a few glass beads in those samples points to magma flowing possibly just 120 million years ago. Though that may sound ancient, it is very recent for astronomical objects.

A mission from India returned even more clues about the once-volcanic near side. The Chandrayaan-3 mission landed near the south polar region in 2023. This mission, too, turned up data on the age of lunar magma. Astrophysicist Santosh V. Vadawale led the team that described those findings last year in *Nature*. He works at India's Physical Research Laboratory in Ahmedabad. His team's data suggest the moon may once have hosted a giant liquid-magma ocean.

Scientists compare that near-side information with what Qian and his colleagues have measured from the Chang'e-6 samples. They continue to understand more about the moon's history.

For billions of years, the force of gravity has bound our moon and planet together. No surprise, then, that our moon is the most explored world after Earth. Dozens of spacecraft have either orbited or landed on it. Twelve astronauts have walked upon it as part of six different missions.

Yet there's still so much to learn. Moon rocks carried back to our world are a library of yet unexplored data, says Petro. Think of them, he says, as "little books. They tell us the history [of our moon]."

And imagine what wonderful new tales await in the volumes that Chang'e-6 has brought back from the moon's far side.

Visitors crowd in at the National Museum of China in Beijing (above) to view lunar rock and debris collected by Chang'e-5. The mission returned rounded glass beads (inset), arranged here to spell out an abbreviation for that mission. A study now suggests several beads, out of 3,000 collected, have a volcanic source.

In this image from June 25, 2024, researchers in Siziwang Banner (north China's Inner Mongolia Autonomous Region) are preparing to retrieve the return capsule from the Chang'e-6 probe. The capsule ferried home the first rocks and soil collected from the moon's far side.

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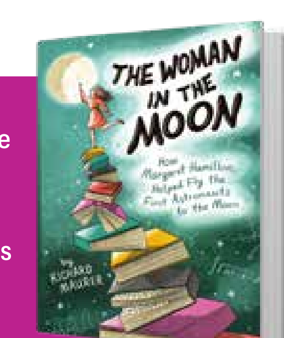
READ MORE

The Woman in the Moon: How Margaret Hamilton Helped Fly the First Astronauts to the Moon

By Richard Maurer

Only 12 people have ever walked on the surface of our moon. How did they get there? This book tells the story of one of the scientists who helped astronauts safely travel to and from the moon.



Electric currents race through your brain, keep your heart on pace and strengthen your bones >>

By Bethany Brookshire

ALEXANDER_P, AVA BITTER, CURIOSITY, REDGREYSTOCK/SHUTTERSTOCK

Our daily lives run on electricity. Electric lights illuminate our rooms. Electric power runs microwave ovens, cell phones and even cars. When we lose access to electricity, it can feel like we also lose access to much of the modern world.

But there's one place where electricity never stops — your body.

Many of our cells are tiny generators of electric charge. Working together, they power systems that keep our bodies going. Every second of every day, electrical signals race through your brain, heart and bones.

By learning more about these tiny electrical signals, scientists are on the road to ushering in new treatments for when the body doesn't work quite as well as it should.

An adult heart usually beats between **40 AND 100 TIMES PER MINUTE** when someone is asleep or resting quietly

Ions charge up cells

The pacing of heartbeats comes from a bundle of cells smaller than two grains of rice lying end to end. It sits at the top of the heart's upper right chamber. Called the sinoatrial, or SA, node, this is the heart's pacemaker.

Natural pumps shove charged atoms — called ions — through the cells' membranes. Their movement concentrates various types of ions on the inside and outside of each cell.

An ion carries a tiny electrical charge. So concentrating lots of ions on one side of a cell's membrane will give that membrane an overall electrical charge. SA node cells pump out lots of positively charged sodium ions. As a result, the outside of their membrane has an overall positive charge.

Cells of the SA node also pump some positively charged potassium ions to their insides. But many other molecules inside the cell have a negative charge. So at rest, a pacemaker cell is more negatively charged inside than out.

To trigger a heartbeat, pacemaker cells in the SA node open channels at one site in their membranes. Because there are more sodium ions on the outside, those ions will rush inside the cell. That ion flow changes the electric charge across the membrane.

Now other channels in the cell's membrane open. This allows potassium ions to go racing out. Again, they're trying to balance their concentrations inside and outside of the cell.

Each channel set opens in one tiny area of a cell's membrane. Ions that rush into the cell change the electric charge a little ways away. This triggers more channels to open farther down the membrane, sending waves of changing electric charge down the length of a cell.

Scientists refer to this zap as an "action potential."

In the brain and many other tissues, cells are using electricity to send messages to each other. Seen at left is an artist's rendering of neurons, with tails sheathed in bulging spans of an insulator called myelin.

PIXOLOGICSTUDIO/SCIENCE PHOTO LIBRARY/GETTY IMAGES PLUS

Keeping time

Cells in the SA node all zap at once. Each collective zap is like the beat of a metronome.

Two tiny clocks set the pace at which this metronome beats, explains Edward Lakatta. He's a cardiologist, a doctor who studies and treats diseases of the heart. He works at the National Institutes of Health Laboratory of Cardiovascular Science. It's in Baltimore, Md. Together, the two clocks keep your SA node generating new electrical zaps at a healthy pace.

LESS THAN A SECOND How long it takes a pain signal to go from foot to brain when you've stubbed your toe

Unfortunately, things sometimes go awry. Cells in the SA node might fire too fast or too slow. Sometimes they might not fire at all. In those cases, doctors might install a battery-powered device to serve as the master pacemaker. It sends timed micro-zaps to the SA node to keep it running.

But the pacing of heartbeats isn't behind all heart problems. Sometimes the vessels that move blood around get blocked. Lacking blood and oxygen, a spot of cells in the heart tissue may die. This is known as a heart attack.

Although many people can survive a heart attack, this event leaves a scar. Here, the heart no longer conducts or responds to electrical signals, which can upset its stable beating.

Ren-Ke Li is a cardiovascular surgeon at the Toronto General Hospital Research Institute in Canada. His team has developed a tiny patch for heart-attack survivors. Made of a gelfoam, this patch can conduct pacemaking zaps across scarred heart tissue to keep healthy cells contracting in unison. A second hydrogel patch reinforces the heart's electrical timekeeping. This pair of gels also provides a scaffold on which new heart cells can cling and grow.

Right now, Li's group is testing these gels in rats. Someday, the patches might help human hearts heal, all the while keeping their electricity flowing.

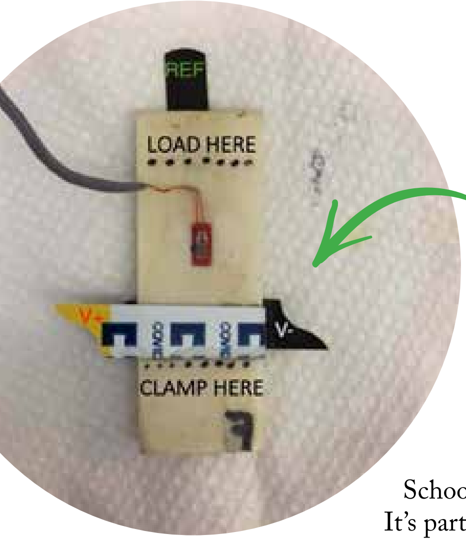
Electricity on the brain

The brain is another hive of electrical activity. Some of its cells — neurons — have long tails, called axons. These serve as paths along which electrical signals travel. Those electrical signals are how the brain processes and transmits information.

Like pacemaker cells in the heart, neurons are more negatively charged on the inside than on the outside. When an electric signal needs to get passed between neurons, ion channels open up in the cell's membrane. As with heart cells, this allows ions to flow in and out — changing the neuron's electrical charge.

Neural signals move fast. A signal can sprint from the nerve cells in your big toe to your spinal cord and into your brain at up to 120 meters (400 feet) per second. So if you've stubbed your toe, you'll know in less than a second. And in another half second, signals from the brain back to the leg and toe will help you hop around in pain.

Groups of brain neurons can also fire together in what's known as oscillations, notes Helen Mayberg. She's a neurologist — someone who studies and treats diseases of the brain. She works at the Icahn



Tiny electrodes can capture electricity coming from this bone as it bends.

School of Medicine. It's part of the Mount Sinai Health System in New York City.

Each oscillation is the sum of all the firing by neurons in a given area. Mayberg likens it to a transportion network — like a network of streets. Some cells in this town take slower routes through the city streets. But others have special bands of insulating material wrapped around their axons (or tails). Called a myelin sheath, each of these bands helps keep ions from escaping so that the electrical signal won't diminish — so the signal can move at highway speeds.

Tiny gaps separate these sheaths from each other along the length of an axon — giving each its own personal space. The uncovered gaps between the myelin sheaths on a neuron's axon are super sensitive to electrical changes. They also have a lot of ion channels.

An electrical signal can skip between these gaps much faster than if it could only ripple along the axon membrane. And it bounces along the gaps in the myelin without the signal getting any weaker. This allows the electrical signals to move at the whip-fast speeds needed to let you know that a stove is hot or you stubbed your toe.

In some brain disorders and diseases, however, something can block the flow of these signals. Perhaps the neurons and their myelin are damaged. Or the cells producing oscillations might get out of sync. Some groups of neurons might even die.

In all these cases, the results can be terrible.

When some neurons in the brain die, for instance, others can start to oscillate out of sync. The body can now get conflicting signals. It may no longer know when to start a movement. This might cause someone's limbs to tremble or they might struggle to walk, reach for things and more. These are symptoms of Parkinson's disease.

Doctors will sometimes implant electrodes deep into the brain to treat Parkinson's disease. High-frequency electrical signals from those electrodes will cut off the problem oscillations, Mayberg explains. Now patients can move normally again, at least for a few years.

Mayberg and her colleagues have begun developing a similar deep-brain stimulation for people with depression. This mental illness can trigger extreme, long-term sadness. Medicines or other treatments can help some people with depression. But other people don't respond well to those therapies. Mayberg's team is finding that a little electricity in the right place can make a big difference for some of these people.

Shocked to the bone

Bones also respond to electricity, says Greg Wohl of McMaster University. It's in Hamilton, Ontario, Canada. Many people think bone is inert — not something that really changes, he says. But bone tissue can adapt, or change, a lot. Sensing electricity is key to that. A biomechanical engineer, Wohl studies how bones respond to physical stress.

And our bones are constantly under stress. You put a mechanical load on your skeleton every time you lift a big backpack, do a handstand — even walk. With each stress, Wohl notes, "little cracks are forming and progressing through the bone."

This tiny slice of beef bone (left) is coupled to a strain sensor (small red square in the center, connected to a black wire) — a machine that measures how much something bends under weight. The white tab above "CLAMP HERE" holds electrodes that detect any electricity coming out.

PIEZOELECTRIC

ADJECTIVE
"Pee-AY-zo-ee-LECK-trick," or "PEE-zo-ee-LECK-trick"
This word refers to a material that produces an electric charge when it's bent or squeezed. Crystals, ceramics, bones and even some proteins can be piezoelectric.

Electricity also controls the beat of your heart
Find out more on page 28

If those cracks weren't repaired, they would build up. The same thing happens to a lot of other hard structural materials, he says. Think about the axles on rail cars, the wings on planes — even the bridges over which we drive our cars. With time, the stress of those heavy loads can wear down the support materials. Eventually, Wohl notes, they'll "need to be repaired by ripping them down or taking them out and replacing them."

But the body can't pop in a whole new bone when one wears out. What it can do is break down and replace affected cells around those cracks.

Bone is made up of three main cell types. Osteoclasts are bone munchers. They break down old, worn-down bone bits and re-absorb them. Osteoblasts help build new bone material where it's needed. In time, this second type will morph into the third type, true bone cells — osteocytes.

In the 1950s, scientists realized that the surface of bone stressed by weight has a slightly negative charge. If the bone bends slightly (not enough to break), it develops a slightly positive charge. When carrying no weight, the bone has no charge.

This means bone is piezoelectric. It produces an electric charge when bent or squeezed. Wohl has seen this in beef bone that his team got from a grocery store. After cutting it up into little domino shapes, his team put electrodes on each side of those bone pieces. "When we bent [the bone dominoes]," he says, "we were able to generate a little spike of charge that slowly dropped off over time."

It's those charges that stimulate bone to make repairs and get stronger. A loaded bone with negative charge stimulates osteoblasts to make more bone. A bent bone with positive charge stimulates osteoclasts to break bone down.

Wohl's team is now investigating which types of electrical pulses might work best to help boost bone healing.

There are lots of devices on the internet that claim to electrically heal or strengthen bone. It's definitely something people should ask their doctors about. Some might help for a broken bone. But it might not make a difference for a bone that's weak with disease, Wohl says.

Scientists are also thinking about how to use those electrical charges to keep bones strong, even when there's no load on our skeleton — such as during spaceflight.

"If we're going to send people to Mars, they're going to be in a spaceship" and weightless for a year and a half, Wohl says. During that time, the astronauts' bones won't feel a need to repair themselves. The risk is that astronauts may "step on to Mars and break a hip."

All those electrical signals that move through our bodies aren't just quirks. We couldn't live without them. Our hearts wouldn't beat, our brains wouldn't function and our bones would break. But with just the right jolts of electricity, scientists may be able to lift people's moods, help their hearts beat in sync and even keep space travelers strong.

This artist's rendering (above) depicts a network of brain cells known as neurons. These and the cells in many other tissues use electricity to send vital messages to each other.

L. PRAVATO; G. WOHL/MCMASTER UNIVERSITY; FATIDO/E+/GETTY IMAGES PLUS

This engineer uses light to get hearts pumping

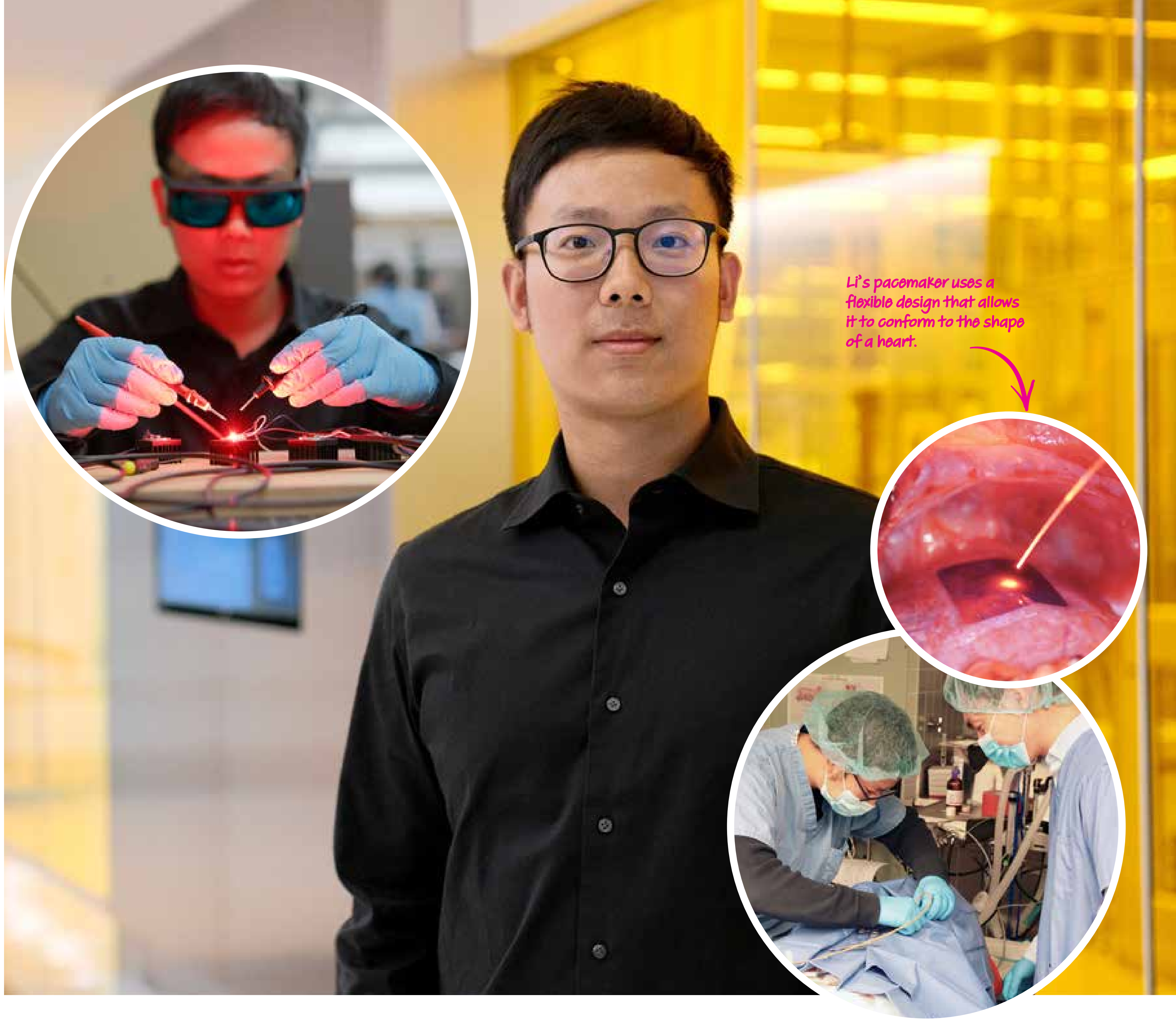
Pengju Li designed a light-powered pacemaker to help doctors during open-heart surgery

Each year, more than 2 million people worldwide undergo open-heart surgery. This involves opening the chest and briefly stopping the heart. Getting hearts pumping again after the procedure can sometimes be risky, says Pengju Li. This molecular engineer designs bioelectronic devices at the University of Chicago in Illinois. These devices treat diseases by stimulating the muscle and nervous system through electricity.

Doctors might restart hearts by compressing them with their hands. “It’s very invasive and demands significant expertise,” says Li. Other times, surgeons use metal tongs and electrodes. But these risk damaging sensitive tissue. Li’s team has designed a light-powered pacemaker that might one day help hearts find their groove after surgery.

Traditional pacemakers use special wires called leads. These send zaps directly into the heart. Li’s device instead relies on layers of silicon that generate electricity when exposed to light from an optic fiber. This flexible membrane is about “100 times thinner than a human hair,” says Li. The device has proven successful so far in rodents and pigs. And it holds promise for use in humans.

Li isn’t just working on hearts. His team is also designing devices that use electric zaps to treat nerve disorders and sleep apnea. This sleeping disorder causes people to briefly stop breathing while asleep. Here, Li shares his experiences and advice with *Science News Explores*. (This interview has been edited for content and readability.)
— *Aaron Tremper*



P. LI

Molecular engineer Pengju Li designs devices that treat diseases using electricity (left inset). His team designed an ultra-thin pacemaker (upper right inset) that uses light to send these zaps directly into the heart. It has been tested in pigs (bottom right inset).

Q How do you get your best ideas?

A One of my strategies involves talking and collaborating with medical doctors. They know about medical devices. They understand what problems may occur during surgeries. I schedule regular meetings with them to share ideas on current medical problems. They might tell me about surgical equipment that can be improved. I can then design a device that meets their needs.

Q What challenges do younger patients in need of pacemakers face?

A Most people focus on heart disease in the elderly. But implanting traditional pacemakers in younger patients can be more challenging. Surgeons can easily implant these devices in adults by passing them through the blood vessels. But children have much smaller veins, preventing us from reaching the heart. This is also true for conditions where the heart is shaped differently than what we typically see.

That’s why we need to develop less invasive methods. Our team has engineered a tool that delivers pacemakers through the ribs. Instead of cutting the ribs, we make a small incision between them. This then lets us implant pacemakers using catheters.

Q How is the field of bioelectronics changing?

A Artificial intelligence is making big changes in the field. In the past, developing new materials often involved many people. We’d hire a lot of people to do tedious work like testing and tweaking material recipes. But now we can automate that work with AI. Recent studies have shown how robots can automate experiments that identify potential medicines and test materials. They’re much faster than humans.

We can also integrate AI into today’s electronic devices. Algorithms can analyze data collected from your body and point out possible issues.

ENGINEERING

Build the fastest paddleboat

A rubber band can propel a cardboard or wood boat across the pool

By Science Buddies

Paddleboats powered by steam engines were common in the 1800s. Today, people drive smaller paddleboats across ponds or lakes with bike pedals. Even smaller, rubber band-powered paddleboats make great pool toys. In this experiment, let's design, test and improve handheld paddleboats to make them go as fast as possible.

OBJECTIVE

Design and build your own rubber band paddleboat

Building your own paddleboat is a great way to explore energy, force, drag and other physics concepts.

ANN IN THE UK, IXEPOP/SHUTTERSTOCK

EXPERIMENTAL PROCEDURE

1. Build a paddleboat using a rubber band and balsa wood, cardboard or popsicle sticks, following the videos at *snexplores.org/paddleboat*.
2. Test your boat in a bathtub or kiddie pool.
3. If the boat did not make it all the way across the tub or pool, measure how far it traveled with a tape measure.
4. If the boat made it across the tub or pool, measure how long it took to travel that distance with a stopwatch.
5. Observe whether the boat travels straight, if it seems to struggle through the water or if it sinks.
6. Based on your observations, how could you improve your boat? Could you change its shape? Add a rudder? Wind its rubber band more tightly?
7. Try making improvements to your boat and test it again.
8. Keep iterating and testing your design until you're happy with the boat's performance.

Find the full activity, including how to analyze your data, at snexplores.org/paddleboat. This activity is brought to you in partnership with Science Buddies.

SCIENCE BUDDIES

These words are hiding in this issue. Can you find them?

The words below came from the stories in this magazine. Find them all in the word search, then search for them throughout the pages. Some words may appear more than once in the issue. Can you find them all?

Check your work by following the QR code at the bottom of the page.

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ADHESIVE
ATRIUM
CHIMPANZEE
CONTAGIOUS
CORAL
CRATER
CYLINDER
DUST
ELECTRICITY
EVOLUTION
GIZZARD
HEART
HYPOTHESIS
INVISIBLE
IRON
LAVA
METHANE
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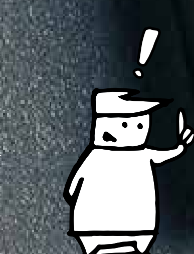
SAVANNA
SODIUM
SYRINGE



PATPITCHAYA/SHUTTERSTOCK

CHEMISTRY

A lucky lab accident produces Spider-Man-like silk

Researchers can shoot out the material and use it to lift small objects

Spider-Man uses his web shooters to catch criminals and whisk innocent bystanders to safety. Now, a real-life adhesive inspired by mussels, moths and spiders can stick to and lift small objects.

LIFESTYLE PICTURES/ALAMY STOCK PHOTO

In comic books, Spider-Man swings from skyscrapers, hanging from super-strong threads of silk. He shoots these sticky threads from his wrists. Now researchers have found a way to mimic this superhero material in real life.

The new material is the first adhesive that can stick to and lift things from a distance, its developers say. It shoots out of a syringe as a liquid, then quickly hardens into a strong thread. And it sticks to almost anything it touches.

Once hardened, the thread can lift objects up to 80 times its own weight. In lab tests, researchers lifted a wood block, steel nuts, a test tube and more. These results appeared in the journal *Advanced Functional Materials.*

Marco Lo Presti has been working on developing sticky materials at Tufts University in Medford, Mass. Fiorenzo Omenetto directs the Silk Lab where Lo Presti works. The two teamed up with chemists at the University of Bari in Italy to create the new material. When the group talked with each other about this work, they always called it the "Spider-Man experiments," says Gianluca M. Farinola, one of the Bari chemists.

For now, though, Spider-Man gets to keep his job. "I don't think you're going to be able to swing off buildings using this yet," notes Rosalyn Abbott. She's a biomedical engineer at Carnegie Mellon University in Pittsburgh, Pa. She did not take part in the research.

"Don't try this at home," agrees Omenetto. Yet even though the new material isn't quite ready to fight crime, it "has superpowers," he adds.

Abbott agrees: "It's very cool."

AN ACCIDENTAL DISCOVERY

As he worked on this project, says Lo Presti, "I was feeling like Peter Parker." That's the fictional superhero's "real" name. In the comics, he's a chemist and engineer.

Peter Parker got his superpowers accidentally, from the bite of a radioactive spider. Lo Presti discovered this superpowered material by accident, too. (But no spiders were involved.)

Back in 2021, Lo Presti had been developing an adhesive that could stick securely underwater. He started with cocoons from silk moths. This is the first step for most of the Silk Lab's work.

The researchers boil the cocoons to break them down. This produces a substance that is basically liquid silk. Lo Presti then mixed in another chemical. This one mimicked a sticky substance mussels produce to secure themselves to underwater rocks.

His underwater adhesive worked well. But then one day Lo Presti was cleaning his lab equipment with acetone. That's the same chemical solvent used in many nail-polish removers. At once, he noticed something strange: His silk mixture rapidly turned solid.

It was "looking like a web," Lo Presti says. Almost immediately he imagined creating some sort of "web shooter" to disperse the material.

And that's what his team has now done.

The team came up with several different silk recipes for their web shooter. These include different additives that alter the thread's properties. One substance makes the silk thread stronger. It solidifies faster, too. Another makes the silk thread stickier, though not quite as strong.

"They really tailored [those recipes] for different applications," says Abbott.

IN SEARCH OF A PURPOSE

Spider-Man uses his web shooter to escape bad guys. He also shoots silk to catch criminals and whisk innocent bystanders to safety. This new material can't do any of those things. Still, it could be put to good use. For example, someone might use it to pick up delicate objects, suggests Omenetto.

Abbott's lab uses silk-based materials in biomedical engineering. Part of her work involves developing bio-inks to use in 3-D printing. A bio-ink is a liquid that can harden into a structure that supports the growth of living cells. The fact that the new material hardens so quickly, she says, might be very useful for this.

Meanwhile, Lo Presti has a different end goal. He hopes to replace plastic-based adhesives with biodegradable alternatives such as silk. "I'm trying right now to work on particle board," he says. Currently, particle-board makers mix wood chips with toxic glues. These do not break down easily. Instead, using silk-based glues could make this and other products "more sustainable," he says.

Peter Parker would surely approve. — *Kathryn Hulick*

This sticky adhesive is made of silk fibers and can lift objects over 80 times its own weight. That's strong enough to lift up a small glass beaker.

The new adhesive works by blending two substances: a silk mixture and acetone. When the two meet in midair, the silk mixture hardens instantly into a sticky thread.

M. LO PRESTI, TUFTS UNIVERSITY

ANIMALS

Nature shows how dragons might breathe fire

Bringing all the ingredients together could get explosive

No fantasy world is complete without a fire-breathing dragon. But if dragons were real, how might they get that fiery breath? The creatures just require a few chemicals, some microbes — and maybe tips from a tiny desert fish.

Fire has three basic needs: ignition, fuel and oxygen. That last ingredient is the easiest to find. Oxygen makes up 21 percent of Earth's atmosphere. The bigger challenges are sparking and fueling the flame.

All it takes to strike a spark is flint and steel, notes Frank van Breukelen. He's a biologist at the University of Nevada, Las Vegas. If a dragon had an organ like a bird's gizzard, it could store swallowed rocks. In birds, those rocks help break down tough foods. Swallowed flint might rub against some steel inside the dragon, sparking a flame.

"Maybe what you have is sort of scales that are flintlike and click together," van Breukelen says. If the spark was close enough to a very sensitive fuel, that might be enough to ignite it.

But some chemicals don't need that initial spark. Pyrophoric molecules burst into flame the instant they contact air. The element iridium is one example, notes Raychelle Burks. She is a chemist at American University in Washington, D.C. Iridium burns different colors when it becomes part of various molecules.

Iron, meanwhile, can react with hydrogen sulfide to produce iron sulfide. Combine it with air and you've got an explosive mix. Iron sulfide is sometimes the culprit when gas pipelines or tanks blow up.

BURNING BURPS

Fictional dragons often spout flaming gas. But a gas would present problems, says Matthew Hartings. He's also a chemist at American University. Gas expands to fill available space. To keep it contained, a dragon would have to keep that gas under pressure.

Also gases are difficult to control. If a dragon blew some fiery gas into the wind, the flames might wash back on the creature and singe its face. "You have a much better chance of controlling your flame spray if you're pushing liquid rather than a gas," he explains.

A liquid would help a dragon avoid burning itself, Hartings notes. The liquid with its flammable gas would ignite as soon as it hit air. Speed is key. "As long as you are shooting it out fast enough, [the] particles don't hit the air until they are far enough away from your face."

A combination of liquid and gas might work even better, Burks suggests. In an aerosol spray, tiny liquid droplets are suspended in a pressurized gas, which spurts out when it is released. If a dragon were to shoot an aerosol spray, it could look like a gas, with some of the properties of a liquid. "In a fine aerosol spray, it would look like the dragon is spraying fire." The aerosol would spread out, she says, "and the minute it hits air — kaboom!"

SOMETHING FIERY, SOMETHING FISHY

Plenty of liquids in nature will burn. Living things already produce two of these that might work for a dragon: ethanol and methanol. Both are alcohols often burned as fuels.

"Certainly, we know that yeast makes ethanol," Hartings says. These single-celled fungi transform sugars into alcohol. They're used to brew beer and make other alcoholic beverages. A dragon with a bellyful of yeast is not as silly as it might appear. Yeast are part of the microbial community that lives on and in people and other animals.

Methanol first requires methane. Ruminants — including cows, goats, giraffes and deer — make methane during digestion. Certain bacteria can turn methane into methanol, Hartings notes. A dragon that got enough fiber in its diet to make methane could pass that gas on to its bacterial buddies, which would convert it into methanol.

But those bacterial coworkers might not even be needed. The Devils Hole pupfish doesn't bother with them. This tiny, rare species lives only in Devils Hole — a naturally heated pool in Nevada. And it can whip up its own whiskey in a pinch.

Temperatures in Devils Hole reach 33 °C (91 °F). When the water gets hot, oxygen levels can drop too low for the fish to breathe. So pupfish stop using oxygen and produce energy anaerobically — without oxygen. In the process, their bodies make ethanol.

A dragon might be able to produce ethanol under similar circumstances. However, van Breukelen says, it's not quite so simple. Ethanol, he explains "goes right through membranes," including the membranes that surround cells and organs. When pupfish produce ethanol, the chemical ends up throughout the fish. So any dragon that made ethanol would have trouble storing enough to get a decent flame going.

— *Bethany Brookshire*

Devils Hole pupfish have the ability to produce ethanol, which helps them survive in a tough environment.

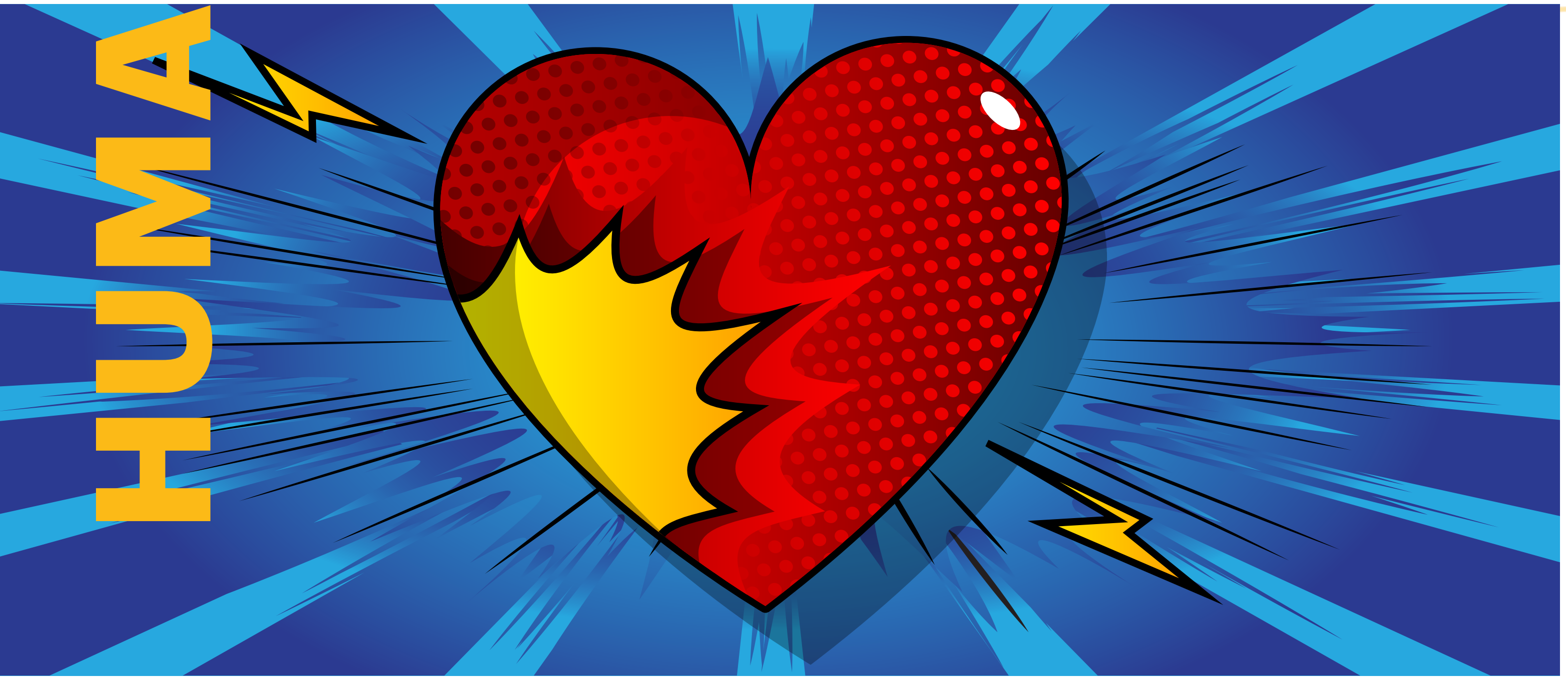
DREAMWORKS ANIMATION/MAD HATTER ENTERTAINMENT/ALBUM; DIPPER HISTORIC/ALAMY STOCK PHOTO

Dragon fire is common in fantasy stories, such as *How to Train Your Dragon: The Hidden World* (right). But if a dragon did exist, nature has plenty of tools to give such a creature fire-breathing abilities.

HUMANS

Anatomy of a heartbeat

Here's how the heart pumps blood to each and every cell of your body



Your heart beats about 100,000 times per day. Each beat pumps blood to the lungs, where it picks up oxygen. Another pass through the heart sends it on to the rest of your cells, bringing nutrients and life-sustaining oxygen and carrying away wastes.

Each heartbeat is divided into two segments, which sound like "lub-DUB." Each beat starts in the heart's two upper chambers — the right and left atrium. The right atrium fills with low-oxygen blood that is returning from a circuit around your body. The left atrium fills with blood coming from the lungs, where it picked up oxygen.

These atria push blood down into two bigger, muscular chambers below them — the right and left ventricles. When the ventricles are full, valves close so the blood can't flow back to the atria. That's the "lub" sound.

Now the ventricles contract. The right ventricle sends the low-oxygen blood to the lungs where it can pick up a new supply of oxygen. The left ventricle takes oxygen-rich blood and pumps it out to the rest of the body. Then the valves in those ventricles close to keep the blood from coming back in. That's the "DUB" sound.

If the four chambers of the heart are a four-piece band, all beating in rhythm, their conductor is the sinoatrial node, sometimes called the SA node or sinus node. It's the heart's natural pacemaker. About the size of two grains of rice laying end to end, it sits atop the right atrium. These cells work together to send a zap of electricity into the heart's two upper chambers.

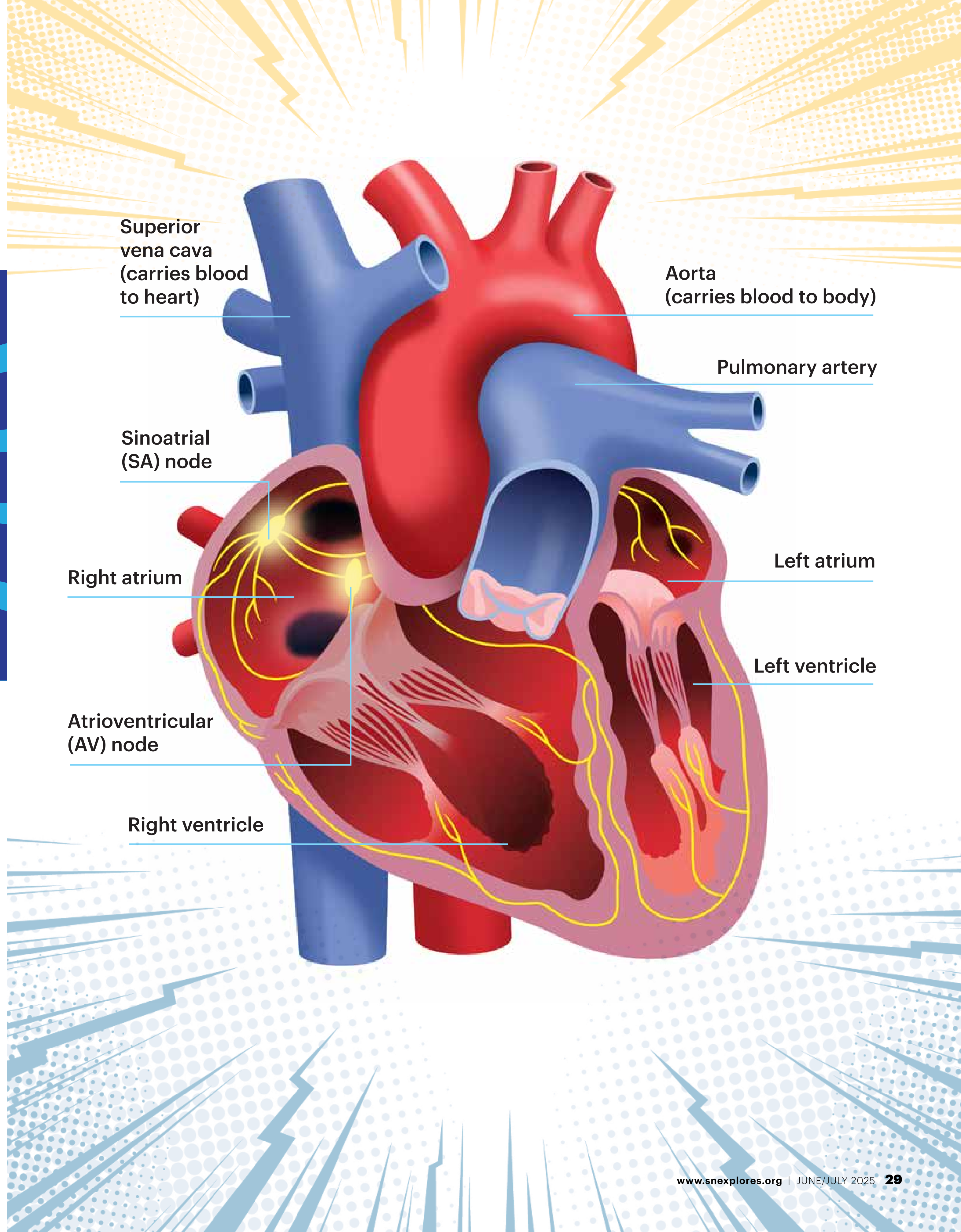
That signal then travels to another clump of cells that sit between the heart's upper and lower chambers. This second clump of cells makes up the AV node. That's short for atrioventricular node. It's an electrical transfer station. The AV node shuttles the electric pacing signal down to the heart's lower chambers. This jolts the muscle cells that make up the walls of each ventricle. Called an action potential, this zap stimulates electrical signals to heart cells — which squeeze in response. This action pumps blood out of the bottom part of the heart and throughout the body.

And then this all happens again and again and again.

— *Bethany Brookshire*

Blood doesn't just go in and out of the heart. Instead, it's a coordinated dance. This drawing shows the heart as though you were facing someone, with their left on your right. Blood from the body enters the right side of the heart, then flows to the lungs to pick up oxygen. It re-enters the left side of the heart before being pumped out to the rest of the body.

NORAVECTOR/ISTOCKPHOTO; ILLUSTRATION BY STEVE MCCRACKEN



ANIMALS

The sweet spot for animal speed

The fastest creatures are big enough to use their strength — but not get in their own way

Cheetahs sprint across the savanna. Impalas, antelopes and other prey gallop away. All these creatures were built for speed. In fact, mid-sized land animals are generally faster than huge or tiny creatures. New research now unveils why.

Christofer Clemente led the work. He studies biomechanics — how animals move — at the University of the Sunshine Coast. That's in Sippy Downs, Australia.

To probe the role of size in swiftness, he and his colleagues could have compared how different animals — such as an elephant, cheetah and mouse — move. But those creatures' leg muscles and movement differ.

"Too many things are changing," says Clemente. It would be hard to identify which factors limit how fast an animal runs.

Instead, Clemente and his colleagues used a computer model of one type of animal — a human — at many different sizes. The team modeled humans ranging from mouse-sized at 100 grams (0.2 pound) to elephant-sized at 2,000 kilograms (4,400 pounds).

The model showed that being bigger lets a creature take longer strides. But there are drawbacks. If a body keeps the same proportions as it grows taller, its mass grows faster than its muscle strength does. The result is an animal that becomes worse at carrying its own weight. That cuts into its speed.

The most massive model humans were so heavy their muscles couldn't move them at all.

Small animals are comparatively strong. But that doesn't make them the fastest. The mini model humans showed why. Small critters' muscles push them off the ground too quickly when they take a step. That decreases the amount of force they can generate to move forward.

"Once they produce enough force, they just become airborne," Clemente says. This is similar to what happens when astronauts walk on the moon.

To lessen their airtime, small animals crouch more than large animals do. Bending their legs more keeps them on the ground a little longer during each step. But they can't take steps as quickly as more upright creatures.

For speed, there's a Goldilocks zone, Clemente says. "That sweet zone where your muscles are still strong, but your body mass is big enough that you can actually use that strength." The researchers shared their results in *Nature Communications.* The findings might help engineers figure out how to design robots for motion. — *Carolyn Wilke*

The fastest land animals aren't very big or very small. Why? Researchers ran models of miniature and supersized humans to find out.

SLOWMOTIONGLI/SHUTTERSTOCK

THE RIGHT SIZE FOR MAXIMUM SPEED

Researchers compared how size and speed stack up for running animals. The x-axis shows animals' body mass, which is related to their volume. The y-axis shows their speed. Figure A compares size and speed for many four-legged animals. That revealed that the speediest animals tend to be a certain size. Then the team modeled humans at many sizes and made a similar graph, shown in Figure B.

FIGURE A

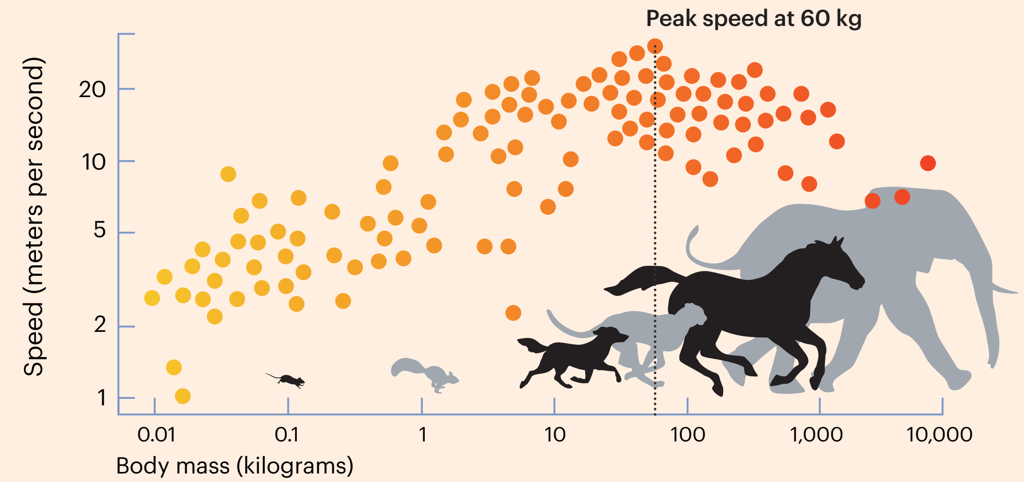


FIGURE B

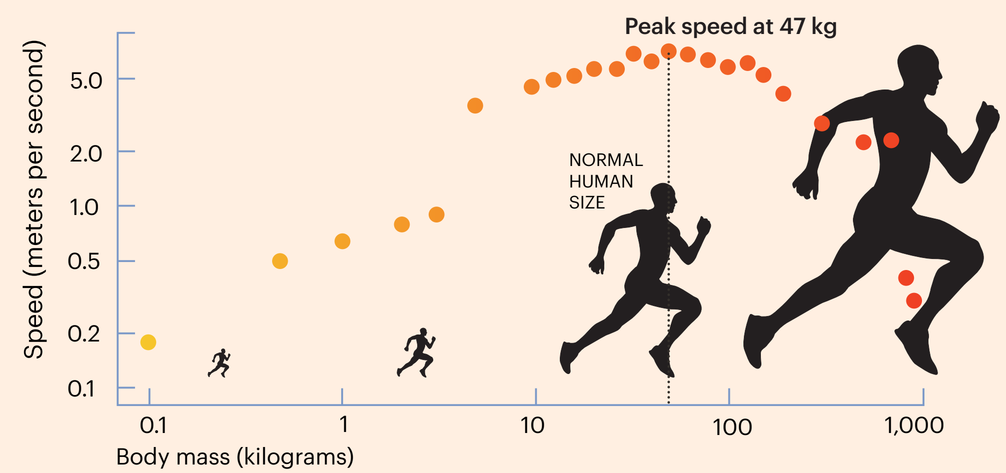
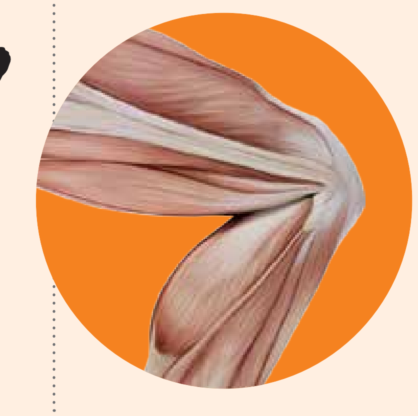


ILLUSTRATION BY STEVE MCCRACKEN; C.J. CLEMENTE *ET AL*/*NATURE COMMUNICATIONS* 2024

When muscles can't keep up with mass

As an animal gets taller, its mass grows faster than its strength does. That's because mass is directly related to volume. But strength depends on the area of a slice of muscle. To see how this works, picture a cube 1 centimeter tall. Its volume is 1 cubic centimeter, and the area of one slice of it is 1 square centimeter. Now, say you have a cube 2 centimeters tall. Its volume is now 8 cubic centimeters. But the area of one slice of it is only 4 square centimeters.



DATA DIVE

1. Look at Figure A. What size of animals have the fastest speeds? What speeds can those animals reach?

2. How much faster is this than the speeds achieved by 1-kilogram animals? How much faster is it than the speeds achieved by animals that weigh around 1,000 kilograms?

3. Look at Figure B. How fast do the smallest model humans move? How fast do the biggest model humans move?

4. What's the peak speed for a human? How does that compare with the peak speed for four-limbed mammals?

What's This?!

ANSWER

The world's largest coral is longer than a blue whale

The huge coral was discovered in the Solomon Islands

Divers measure the world's largest coral off the coast of the Solomon Islands. Researchers suspect the behemoth is at least 300 years old.

MANU SAN FÉLIX, NATIONAL GEOGRAPHIC PRISTINE SEAS

Scientists have found a coral that's so huge it can be seen from space.

The coral was discovered in October off the coast of the Solomon Islands. That's a small nation in the southwest Pacific Ocean. The coral measures roughly 34 meters (111 feet) wide, 32 meters long and 6 meters (19 feet) tall. That makes it the world's largest standalone coral colony.

Corals are groups of tiny animals. These individual polyps cluster together to build rigid skeletons out of calcium carbonate. Scientists estimate that nearly one billion polyps constructed the newfound coral.

Coral provides a habitat for over a quarter of all sea species, notes coral scientist Eric Brown. He's with the National Geographic Society's Pristine Seas team, which found the coral. Brown spoke about the discovery at a news conference.

The species is known as the shoulder-blade coral (*Pavona clavus*), thanks to clusters of protruding ridges. The team estimates that this new record holder is 300 to 500 years old.

While the newfound coral appears healthy, coral reefs around the world face many threats, including plastic pollution and coral bleaching. "It's important for us to do whatever we can to protect these environments that are both small, yet mighty," says Brown.

— *Nikk Ogasa*

INSIDE THE MIND OF A YOUNG SCIENTIST

A Regeneron Science Talent Search finalist answers three questions about her science

Science competitions can be fun and rewarding. But what goes on in the mind of one of these young scientists? Addison Shea, a finalist at the 2025 Regeneron Science Talent Search, shares her experience.

Q What was your favorite part of your project?

A Addison studied how bowhead whale migration is influenced by an ocean current called the Beaufort Gyre, located off the northern coasts of Canada and Alaska. "I really loved the challenge of it," she says. "And then the idea that I was discovering something." Her research suggests changes in whale movements might hint at changes in their prey's movements. The gyre "could be having this really resounding impact on the ecosystem," Addison says. "I just love taking those connections and understanding the hows and the whys."

Q What was the most challenging part?

A "I actually came to a minor roadblock early on," Addison says. She didn't have the right data to perform the type of statistical analysis she'd planned, so she had to revamp her methods. "Having to pivot and look at literature and find out what exactly works for this data ... that was a challenge."

Q What were your most important resources?

A "Probably my AP Research teacher," Addison says. "When I started the project, I knew nothing about the Beaufort Gyre, bowhead whales or anything. I was really this amateur." Trying to figure out what she could add to research done by professional scientists "was really daunting," she says, "and [my teacher] gave me a lot of confidence."

Regeneron Science Talent Search finalist

Addison Shea

Addison, 18, studied how bowhead whale migration patterns have changed in recent years. She hypothesized that a shifting ocean current could impact the whales and their prey. Addison recently graduated from Lakewood Ranch High School in Bradenton, Fla.

Learn more about the Regeneron Science Talent Search

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