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MAY 2026



TECH OF TOMORROW

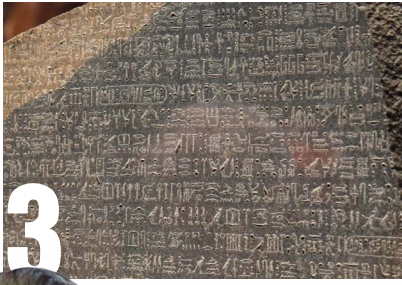
Get a sneak peek of
your possible future

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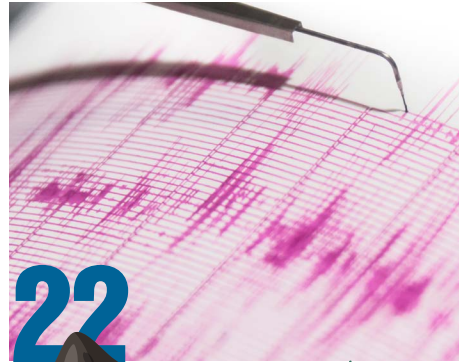
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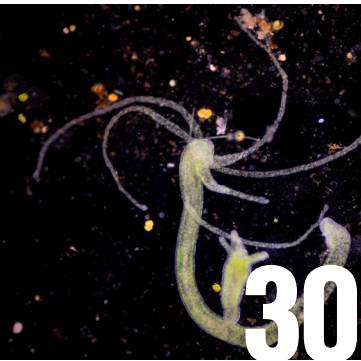
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STEVE MCCrackEN



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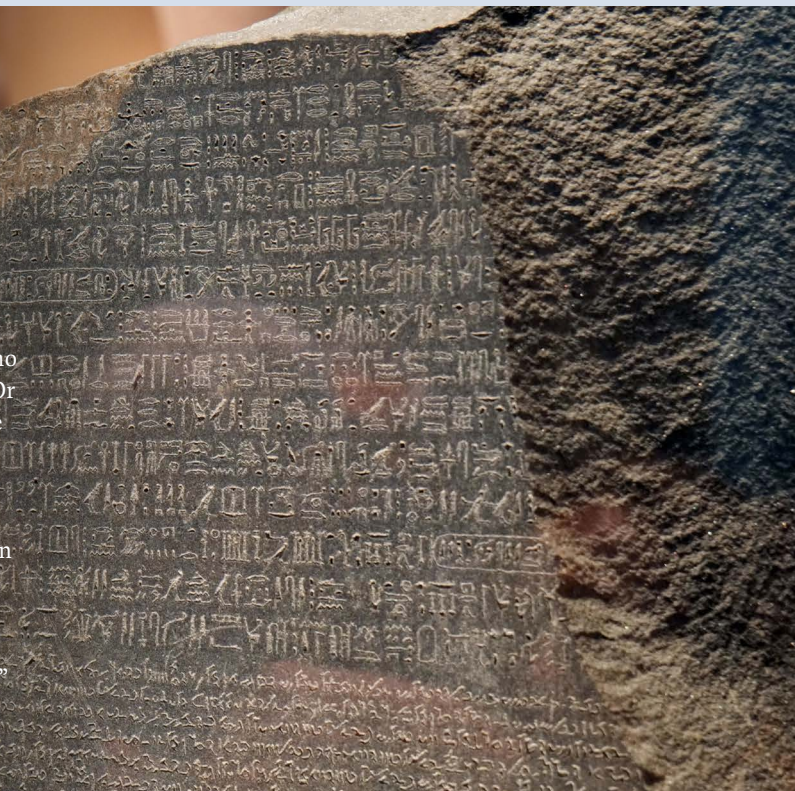
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Q How do scientists figure out what ancient writing says?

— Jett F.



A Scholars can use a few different clues to figure out how to read a lost ancient language. “If you’re really lucky, you’ve got a translation into another language you can read,” says Roland Enmarch, who studies ancient Egypt at the University of Liverpool in England. Or a modern language that’s related to the dead language might give clues about the structure. Take the hieroglyphic writing system used in ancient Egypt from about 3200 B.C. to 400 A.D. Scholars were able to decipher it in the 1800s thanks in large part to the Rosetta Stone (right) — a rock slab etched with the same decree in Egyptian hieroglyphs and ancient Greek. More clues came from another known language called Coptic, which descended from hieroglyphs. “Having a bilingual text and also having this descendent language, they were able to put these things together,” Enmarch says, “and gradually work out how the script and ultimately the language it writes works.”



Q Why can you never find the end of a rainbow?

— Emma A.



A “A rainbow is not a physical object,” says Henrik Wann Jensen. He’s a computer scientist at the University of California, San Diego. He’s studied how to simulate rainbows in computer graphics. Rainbows are optical illusions that appear when sunlight strikes drops of water in the air in a particular way. A rainbow’s location depends on the positions of three things: the sun, water droplets and the viewer. “As a person moves, the direction of the sun ‘moves with them’ and, consequently, the rainbow moves as well,” says Jensen. “Therefore, [a rainbow] can never be caught.” Rainbows look arched when viewed from the ground at low elevation. But from above, rainbows are actually complete circles with no end. “We only see the arc hanging in the sky because the bottom half of a rainbow is obscured by the horizon,” says Xiyue (Sally) Zhang. She is a physicist at the University of Nevada, Reno. “If you are on a mountain or flying in the sky, with some luck, you might see a circular rainbow.”

B. ROBINSON/SHUTTERSTOCK

Q What’s the oldest that a human can get?

— Grant B.



A The oldest confirmed age of any human is 122 years. That record belongs to Jeanne Louise Calment, who died in 1997. But most people don’t live nearly that long. The average life expectancy, or how long someone can expect to live, worldwide is about 70 years old. While genes may play a role, they aren’t the whole story, says Juan Manuel Vazquez. At Pennsylvania State University in University Park, he studies anti-aging genes. Eating healthy, exercising regularly and avoiding risky behaviors such as speeding can help someone live longer, he says. But chance also plays a big role. In the United States, unintentional injuries are the leading cause of death in those under 45 years old. And those born in countries where there is more violence or limited health care tend to live shorter lives. To live to 120, “it really is about having the right cards in your hand at the right time,” he says.



Do you have a science question you want answered?

Reach out to us on Instagram (@SN.explores), or email us at explores@sciencenews.org.



FOSSILS

This dinosaur debate may be dead

Fossils are from a *Nanotyrannus*, not a teen *T. rex*

For decades, researchers debated whether a small dinosaur was a teen *Tyrannosaurus rex* or another species. Two new reports now say it was no *T. rex*. It was an adult *Nanotyrannus lancensis*.

Researchers unearthed a skull of this dinosaur in 1942 in Montana. The skull was 60 centimeters (2 feet) long. It was first thought to be a *Gorgosaurus*. Then in 1988 some scientists said it was a new species, *N. lancensis*. Other researchers said it was a juvenile *T. rex*.

Lindsay Zanno and James Napoli are paleontologists. Zanno works

at North Carolina State University in Raleigh. Napoli is at Stony Brook University in New York. They studied a nearly complete 5.5-meter-long (19.7-foot-long) tyrannosaur skeleton. It was also once thought to be a young *T. rex*. But their findings suggest it was an adult *N. lancensis*.

Growth rings in the tyrannosaur's leg and arm bones suggest that this dinosaur was full-grown. Also, the tail and arm bones are different from those of a *T. rex*. The tail of a *T. rex* has more vertebrae. And *Nanotyrannus* sported larger arms

than its famous cousin, Zanno says. Zanno and Napoli published their findings in *Nature*.

Another team took a new look at the skull found in 1942. Christopher Griffin, a paleontologist at Princeton University in New Jersey, led this work. In a study reported in *Science*, he and his colleagues focused on a tubelike throat bone called the hyoid. Like limb bones, it can accumulate yearly growth rings. These rings showed that the skull that started the debate was an adult *N. lancensis* after all.

— CAROLYN GRAMLING

Family feud?
This illustration depicts a juvenile *T. rex* fending off a pack of *Nanotyrannus* in the Late Cretaceous Period.

ANTHONY HUTCHINGS

ARTIFICIAL INTELLIGENCE

Chatbots may make learning feel easy — but it's shallow

Googling leads to deeper learning than using AI

When learning something new, old-fashioned Googling might be a smarter move than asking ChatGPT, a new study finds.

Large language models, or LLMs, are artificial-intelligence (AI) systems that power chatbots such as ChatGPT. Increasingly, people are using chatbots to get answers. That's instead of traditional web search tools such as Google, Bing or DuckDuckGo. But people who used a web search to look up information developed deeper knowledge than those who relied on an AI chatbot, concludes a new study in *PNAS Nexus*.

"LLMs are fundamentally changing not just how we acquire information but how we develop knowledge," says Shiri Melumad. At the University of Pennsylvania (or Penn) in Philadelphia, she studies how people decide which products to use. Studies about LLMs' benefits and risks could help people use them better, she says. It could also help design better tools.

Partnering with psychologist and data scientist Jin Ho Yun, Melumad compared what people learn through LLMs versus regular web searches. Some search engines now give an AI-generated answer along with a list of websites. But a regular web search just gives a list of websites with related information.

Across seven experiments, they randomly assigned more than 10,000 people to research different topics. These included how to grow a vegetable garden or how to lead a healthier life. Participants used Google or ChatGPT. Afterward, they summarized their findings as advice

written for a friend. The researchers then asked the participants to gauge how much they learned.

GOING DEEP

In some tests, the researchers controlled what information was available. For instance, they provided identical sets of facts in the LLM and web search. The researchers judged whether this knowledge was "shallow" versus "deep" based on what participants reported. They also used evaluations by human judges and tools that extract information from text. The result? Knowledge gained from chatbot summaries was shallower than with that gained from web links.

People who learned via LLMs produced less informative content. LLM users also were less invested in the advice they gave. They were less likely to adopt this advice compared to those who used web searches.

"The same results arose even when participants used a version of ChatGPT that provided web links to original sources," Melumad reports.

When people use web searches, they figure out how info from different sources fits together. LLMs can reduce the need to do this, Melumad concludes. "This ease comes at the cost of developing deeper knowledge on a topic." However, she notes, developers could design AI-using search tools that encourage users to dig deeper.

Daniel Oppenheimer is a psychologist at Carnegie Mellon University in Pittsburgh, Pa. The results show that LLMs reduce the motivation for people to think independently, he says.



People could follow the links given by ChatGPT or fact-check the information it gives. This could provide some of the benefits provided by web searches. So Oppenheimer doesn't want people to abandon using LLMs. "The effectiveness of the tool depends on how you use it," he says.

— PAYAL DHAR

ARCHAEOLOGY

60,000 years old

That's the age of the oldest known poison arrowheads, found in South Africa



Source: S. Isaksson *et al*/Science Advances 2026

SPACE

‘Mini-lightning’ crackles on Mars

NASA’s Perseverance rover recorded zaps generated by dusty gusts



rub two balloons together.) On Earth, countless such interactions occur within sandstorms and volcanic ash plumes. Particle collisions build up electrical fields that eventually discharge as arcs of electricity.

The phenomenon is called triboelectricity.

Chide and his colleagues previously recorded the sounds of a Martian dust devil. In them, they heard a loud clicking. At the time, they thought it was the sound of dust grains striking the microphone. But one day, Chide heard other scientists at a conference discuss Martian triboelectricity. That led to a shocking realization: Those clicks might have been zaps.

To find out, his team modeled the electrical interference that the rover’s microphone would pick up from a nearby discharge. The models perfectly matched what the mic had picked up.

Excited, the researchers reviewed 28 hours of recordings taken over two Martian years. A total of 55 discharges occurred within about two meters (6.5 feet) of the microphone. Most occurred at the windiest times. Sixteen showed up during dust devils.

There are thousands of kilometers (miles) of dust-storm fronts on Mars that can make these jolts, Chide says. So “we think there are plenty of these small discharges happening.”

— Nikk Ogasa

When Martian winds loft dust into the air, as in this illustration, interactions between the grains can generate electrical fields. Those fields eventually spark mini-lightning.

When the wind blows on Mars, electricity crackles through the air. And for the first time, scientists have detected this.

NASA’s Perseverance rover — aka Percy — captured the data. Its microphone recorded sounds and electrical interference from dozens of electrical discharges. They had been sparked by colliding dust grains.


Researchers shared their discovery in *Nature*.

The electric jolts were fairly small. Each was only about as strong as the shock from touching a doorknob on

a dry, winter day. Still, they could pose a risk to future astronauts and electronics. They also could make it harder to search for Martian life.

It’s “like mini-lightning,” explains Baptiste Chide. This planetary scientist works at the University of Toulouse in France. These discharges are “centimeter-scale electric arcs,” he says. Each one that his team detected produces a crack and a shock wave.

When airborne particles slide against or bump into each other, their surfaces can become charged. (This is similar to what happens when you



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

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RADIOACTIVE ANIMALS EXPOSED

**Wild species at nuclear sites may not glow,
but they reveal risks of radiation exposure**

BY JENNIFER WEEKS

This red fox was spotted in 2017 in the deserted town of Pripyat, Ukraine, near the former Chernobyl nuclear power plant. Animals like this one can help people learn about radioactive areas and how to protect ourselves.

SEAN GALLUP/STAFF/GETTY IMAGES NEWS





In comic books and movies, radiation can be a source of superpowers. The bite of a radioactive spider turned Peter Parker into Spider-Man, allowing him to spin webs and swing between buildings. After a dose of gamma radiation, Bruce Banner could transform into the powerful Hulk.

Real-life creatures can pick up radiation on or in their bodies, too. When this happens, though, they don't get or pass along superpowers. Nor do they glow, as is often shown in popular media.

Animals exposed to radiation may look healthy and act normal. But radiation can damage cells and tissues. And once in the environment, radioactive materials can pose risks that last a long time. Scientists want to understand these threats.

Consider the July 2025 case of four radioactive wasp nests. Workers found them at a South Carolina site that once made ingredients for nuclear weapons. The wasps might have touched radioactive materials that had not been properly sealed off. Or they may have used radioactive wood to make their nests.

This area is being cleaned up. And the nests were far inside the site's borders, so they didn't threaten the public. But these nests do raise questions about how wildlife — and maybe people — get exposed to radiation.

Some places, such as damaged nuclear power plants, are so radioactive that people can't go near them without heavy protection (and even then, not for long). Fortunately, signs tend to warn us to steer clear of such sites. But animals can't read those signs.

As with the wasps, studying where and how species become exposed can help pinpoint risky spots. And knowing how radioactivity affects wildlife may offer tips that will better protect us, too.

RADIATION IS RISKY

Some chemical elements are naturally unstable. They attempt to become stable by shedding energy as tiny, subatomic particles and/or light. This process



is called radioactive decay. The energy they release is known as ionizing radiation.

Radioactivity is natural — and everywhere, notes Kathryn Higley. She works at Oregon State University in Corvallis. As a radioecologist, she studies how radiation affects living things in the wild.

Unstable elements — or radioactive isotopes — exist all around us. They're found in rocks, soil and rainwater. They're in the ocean and the air we breathe. As we eat, drink and inhale these materials, our bodies will become slightly radioactive, too. This "isn't necessarily cause for alarm," says Higley. Our bodies can repair some of the damage small doses of radiation can produce.

Too much ionizing radiation, however, can overwhelm those repair systems. Then its harm to our cells and their DNA — the chemical instructions for making each of us unique — can become permanent.

Exposure to low levels of radiation may not cause visible harm. But over time, hidden damage can build up. Over many years, even small amounts may increase our risk of cancer.

If you've had X-rays taken of your teeth at the dentist, you may have had a heavy blanket placed over your torso. It contains the metal lead. That protects unscanned organs from the X-ray radiation.

Risk of radiation exposure is also why people in some regions test their basements for radon. This radioactive gas is released by isotopes in soil. It can seep into homes. Breathing it can, over time, increase someone's risk of lung cancer.



A sign at the edge of a forest in Belarus, next to Ukraine, warns of radiation contamination 30 years after the 1986 Chernobyl accident. The sign says that it is forbidden to pick berries or mushrooms. Plants and fungi may have absorbed radioactive isotopes from the soil.



A fence within the Fukushima exclusion zone still limited public access in August 2021, more than 10 years after the nuclear disaster in Japan.

HANFORD SITE/U.S. DEPARTMENT OF ENERGY (PUBLIC DOMAIN)



Elk move across the Hanford nuclear site in Washington state – probably because hunting is not allowed there.



High doses of radiation can prove deadly. Intense exposures might come from an accident at a nuclear power plant or indirect exposure to the effects of a nuclear weapon.

NUCLEAR WASTELANDS

In the past 40 years, two big radiation disasters contaminated enormous areas. Even today, they continue to threaten the health of people and wildlife.

The 1986 explosion and fire at Ukraine’s nuclear power plant in Chernobyl, in what was then the Soviet Union, blasted out huge quantities of toxic debris. Much of the material fell nearby. A lot also traveled as fallout — radioactive dust and gas — into Europe and what is now Russia.

Another big accident, in Japan, was triggered by a 2011 earthquake and the tsunami it unleashed. The quake and devastating ocean wave damaged a coastal nuclear power plant at Fukushima. Its reactors spewed radioactive fallout into the air and sea.

At both Chernobyl and Fukushima, government officials evacuated thousands of people from large areas. They created these so-called exclusion zones to keep the public safe. Signs warned the public to avoid the toxic regions.

The Chernobyl exclusion zone covered some 4,150 square kilometers (1,600 square miles). That’s bigger than Rhode Island. People still can’t legally live in the exclusion zone, although tourists can visit it on special tours.

“As humans, we like to test our boundaries,” observes Kate Brown. “Visiting places like Chernobyl is an example.” A historian at the Massachusetts

Institute of Technology in Cambridge, Brown has studied the health of people exposed to nuclear fallout.

The Fukushima evacuation zone covered about 800 square kilometers (300 square miles). That’s about the size of New York City. As radiation levels decreased, Japanese officials shrank the exclusion zone. People who once lived in parts of it can now visit their homes. Only a small number have moved back.

WILDLIFE WARNING SIGNS

Exclusion zones protect people. But animals don’t understand boundaries or visiting limits. So they may hang out in these landscapes and become contaminated.

Consider a wolf, Higley says. It might pick up radioactive material if it “walked through a contaminated landscape,” she says. “Or by eating smaller radioactive animals,” such as mice. That could transfer radioactive material to its own body.

Different materials get stored in different body parts. Cesium-137 is one radioactive isotope. The body can mistake it for potassium, a muscle-building nutrient. As a result, cesium-137 can build up in animals’ muscles. Another radioactive isotope, strontium-90, looks and behaves like calcium, used in making bones. So strontium-90 can get picked up and stored in bones.

In 2023, scientists reported traces of a radioactive uranium isotope in the shells of desert tortoises in the southwestern United States. Radioactive materials also turned up in sea turtles in the South Pacific. The animals might have eaten plants or algae that

had absorbed radioactive isotopes left from nuclear weapons tests (see box at right). Or they might have dug into radioactive sand.

Radiation is a well-known risk at a site called Hanford. It's in central Washington state. For more than 40 years, the U.S. government produced plutonium here. It's a radioactive element that powers some nuclear weapons. That work ended in the late 1980s. But workers are still cleaning up and securing dangerous radioactive wastes.

Some of those wastes were dumped into the soil. Some are now leaching into the nearby Columbia River. More wastes are stored in old underground tanks that are now leaking. This soil will remain hazardous for thousands of years.

Higley studied radiation and health risks during the Hanford cleanup. Burrowing animals sometimes dug into low-level nuclear-waste sites, she recalls. And some plants, like tumbleweeds, had long taproots that could penetrate into nuclear-storage areas. That could move radioactive isotopes into their tissues, where they might be eaten by animals.

Scientists have found radioactivity in mice, rabbits, coyotes and other animals at Hanford. Cleanup crews even turned up radioactive rabbit poop. It had to be buried with other low-level radioactive trash.

Findings like these have shaped safety practices here and elsewhere.

At nuclear power plants, monitors “regularly go out and sample in the area,” Higley says. They may test people’s garden vegetables or farm animals, as well as soil, air and water. That can show whether plants or livestock are radioactive.

Tatsujiro Suzuki was a member of Japan’s Atomic Energy Commission when the Fukushima disaster happened. Now he leads Peace Depot. It’s a nonprofit group that

works to reduce nuclear risks. Suzuki wants this type of sampling done around Fukushima. People who move back there need to know what risks still exist.

Around Fukushima, “mountains and forests near those areas have not been decontaminated and will never be,” he explains. “Wildlife in those areas can still be affected by higher radioactivity” and leftover radioactive materials.

Samples show that wild boar and mushrooms from those areas contain radioactive contamination, he reports. The levels are higher than Japan’s government deems safe to eat. Suzuki worries that food chains pose long-term concerns due to a risk of cancer.

Food-related risks can emerge anywhere radioactive materials exist — and even affect people. In fall 2025, for instance, the U.S. Food and Drug Administration was investigating frozen shrimp. It had been imported from Indonesia. They found some were tainted with cesium-137. Officials worry that could have harmed diners.

HARM OR HELP?

Like humans, wildlife exposed to radiation can suffer DNA and cell damage. Our “systems are very much affected by ionizing radiation,” says Timothy Mousseau.

Mousseau is a biologist at the University of South Carolina in Columbia. He has spent years studying



These fish samples from a market near Fukushima will be sent to a lab to be tested for the presence of radioactivity.

The Przewalski's Horse (inset) is an endangered wild horse in Asia. Around 30 of these horses were introduced into the Chernobyl exclusion zone in 1998. In 2018, scientists counted more than 140 individuals.

Changes seen in male barn swallows found near Chernobyl and Fukushima may make it harder for the animals to reproduce.

wildlife at Chernobyl, Fukushima and other radioactive sites. “Genetic damage is widespread and has shown up in nearly every study that’s looked for it,” he says. But “we see tremendous variation between individuals, species and groups of species in how they respond.”

Mousseau is part of a team that found fewer birds and insects in areas at Chernobyl with more radiation. These hotspots also had fewer mammals, such as foxes and hares.

He’s also seen strong effects on barn swallows at both Chernobyl and Fukushima. “Most of the barn swallows in the most-contaminated areas at Fukushima disappeared within the first two years,” he says. Birds at Chernobyl showed abnormal effects, “like white patches of feathers.”

A closer look at those birds revealed damage to their DNA. Gene mutations may explain the albino feathers in some birds.

For one 2020 study, researchers mounted more than 100 cameras to track wildlife near Fukushima. These captured thousands of photos of boar, raccoons, foxes, weasels, deer and other animals. Many species were more abundant after the disaster.

At Chernobyl, too, many animals roam freely in the exclusion zone. These include wolves, deer, lynx, brown bear and bison. Wild plants are growing in zones that once were tree farms.

Higley isn’t surprised to see animals abounding in such regions. “Radioactivity is a stressor” for animals, she notes. “Just like harsh temperatures or a lack of water.” But, she adds, “the presence of people is also a stressor for plants and wildlife.” Keeping people out made it easier for some species to enter.

Mousseau agrees that excluding people helps wildlife thrive. “Animals that range widely, like wolves, don’t show significant [radiation] effects because they don’t stay in the same place for long,” he says. “But in areas [with] high radiation, there are dramatic negative impacts.”

There’s no magic tool like kryptonite to neutralize radioactivity’s power. Some tainted sites are unlikely to ever be safe places for people to live. But studying creatures that range, burrow and hunt in those areas can help scientists learn more about radiation’s lasting impacts. Some, like the South Carolina wasps, may even serve as sentinels — helping spotlight danger spots so they can be cleaned up. ▶

NUCLEAR WEAPONS TESTS MANY DECADES AGO HAVE LEFT A RADIOACTIVE LEGACY

From the 1950s through the early 1990s, countries — mainly the United States and Soviet Union — built and tested thousands of nuclear weapons. This littered the planet with radioactive debris.

U.S. testing took place in western states (such as the Nevada desert below) and on Pacific islands. The Soviets tested their nukes at sites in Russia and other Soviet republics.


People living near nuclear sites were sometimes exposed to radioactive materials. Winds carried this toxic dust and other stuff downwind of the sites. Communities in the wind’s path showed high levels of cancer, thyroid disease and other illnesses.

Some radioactive materials can take decades or even centuries to decay. So their threat can linger for a very long time. One of the main radioactive substances released by nuclear explosions is cesium-137. It takes 30 years for 50 percent of it to decay.

A layer of that isotope and others (such as plutonium) were left behind in soil and sea sediments. They now serve as a lasting record of the era of aboveground nuclear testing.

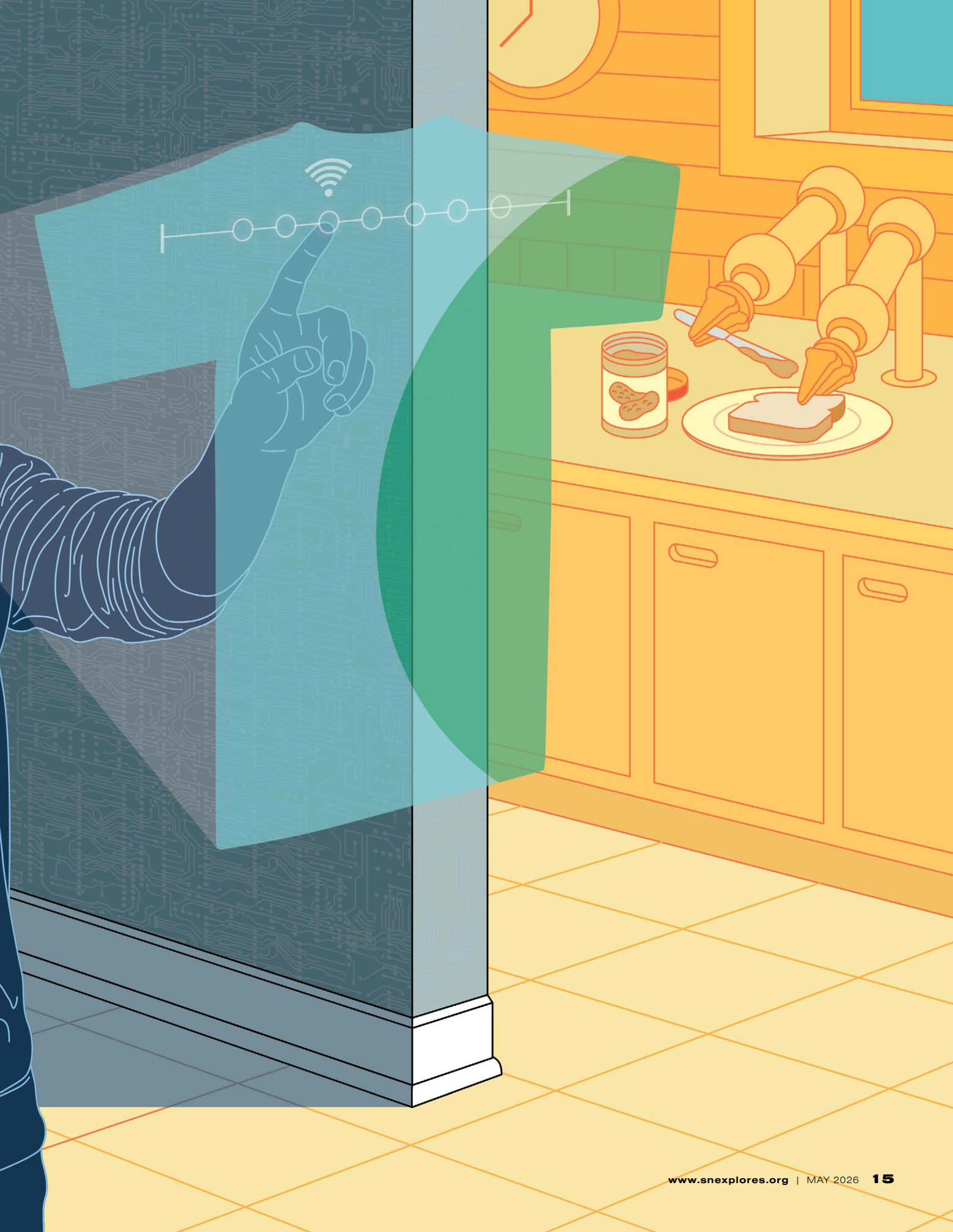


TECH OF TOMORROW

A stylized illustration of a man with glasses and a hoodie, looking towards the right. The background features a futuristic setting with a tablet displaying a Wi-Fi symbol and a glowing green bar. The overall color palette is dominated by blues and greens, with a yellow grid pattern at the bottom.

Get a sneak
peek of your
possible future

BY KATHRYN HULICK





You wake up and yawn, then put on a special pair of glasses. As you're getting ready for the day, a friend calls. The glasses project an image of your friend in front of you, like a hologram.

"I designed a new shirt," they tell you. An image of a stylish top appears in front of your eyes. You spin it around in midair with a swish of your fingers. You send the file to a 3-D printer in the next room. As it whirs away, a helper robot makes a sandwich for your lunch.

Later, as you pull on a pair of shoes — 3-D printed to fit your feet perfectly — your glasses ding with an alert. A message appears in the air in front of you: A ring on your finger has detected changes in your body that signal you might be getting sick. You wear that ring all the time to track your health. It never needs charging because it powers itself from your body heat.

You pull on your just-printed shirt, grab an extra water in case you're getting sick and head out the door.

In 2026, this morning routine is entirely science fiction. But during your lifetime, all of these moments could become normal. Engineers and entrepreneurs are working on every single one of those technologies.



HANG OUT AS HOLOGRAMS

In *Star Wars*, R2-D2 beams a hologram of Princess Leia asking for help. She appears in midair, visible from all sides. That's not realistic, notes Alex Kvasov.

Glasses that produce 3-D illusions are quite real, though. He imagines that one day we might put on such glasses to have a virtual hangout with friends. Or you might experience a football game as if the stadium is "on the table in front of you."

Kvasov is working to make this future a reality at CREAL. It's a company he co-founded, based outside Lausanne, Switzerland. The glasses this company makes now are hooked up to a complex system of optics.

These optics project a series of rapid images — up to 6,000 per second — toward each of your eyes. These images show slightly different angles of one or more objects, based on how their light would reach your eyes if they were real. The brain combines all the light coming through the glasses (from reality and from the illusions) into a scene that makes sense.

Most impressively, the virtual objects come into focus or blur realistically, based on where you look.

The optics and computers — not to mention the batteries it takes to run this tech — don't yet fit into one slim pair of glasses. The augmented reality glasses already available for sale are pretty bulky. And they don't yet project realistic depth. But the tech is improving rapidly.

PRINT YOUR OWN OUTFIT

When Gihan Amarasiriwardena was a teen growing up in Massachusetts, he loved camping and wanted to make his own gear. So he glued pieces of fleece to a plastic garbage bag to make a warm vest. "Wearing a trash bag is exactly how it feels," he recalls. Hot and sweaty.

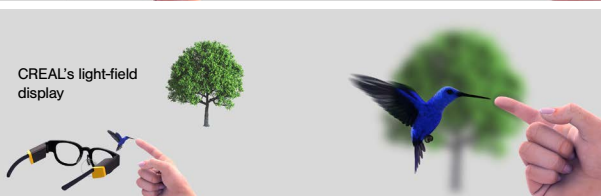
Now, this engineer invents new (and more stylish) ways to make clothing at a business he co-founded. Called Ministry of Supply, it's based in Boston, Mass. The 3-D printers he works with are called computerized knitting machines. They weave together threads or yarns. Most of these machines are as big as a refrigerator, he says.



Current Augmented Reality displays

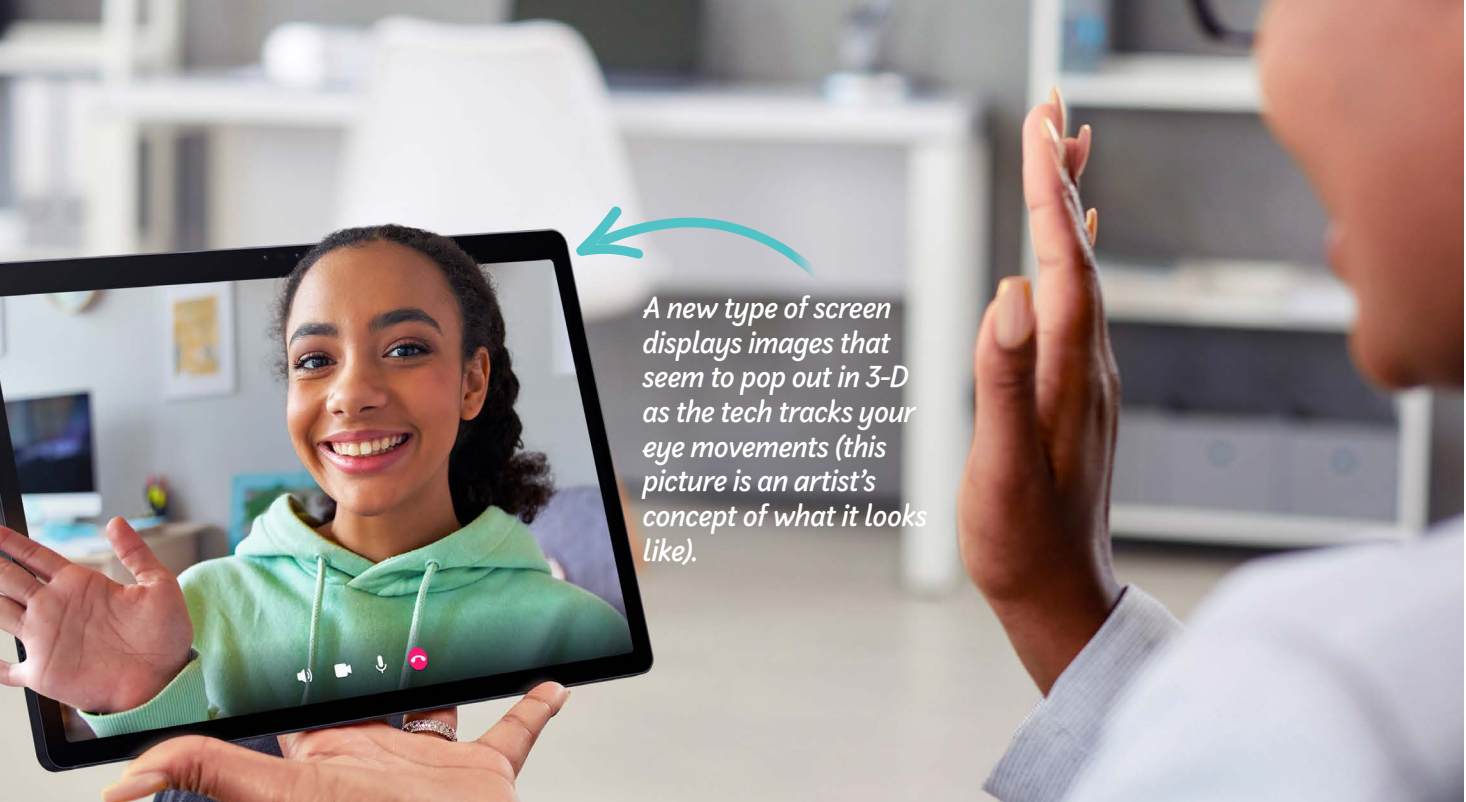


CREAL's light-field display



CREAL has created prototypes (left, insets) of their holographic glasses. The glasses let virtual objects come into focus or blur more realistically (lower panel) than the augmented reality displays currently available (upper panel).

© CREAL: VIVOBAREFOOT



A new type of screen displays images that seem to pop out in 3-D as the tech tracks your eye movements (this picture is an artist's concept of what it looks like).



At Ministry of Supply, you can watch a robot use a heat gun to morph a 3-D printed dress (left) into a new style (right). The dress “has two fibers, one that reacts to heat and shrinks and one that doesn't react to heat,” explains Gihan Amarasiriwardena.

company makes what it calls a scan-to-print-to-soil shoe. (The “soil” part refers to the shoes' environmentally friendly materials.)

To get a pair, Clark explains, someone “scans their feet, picks the style, the color.” A computer program maps the style to the shape of their foot. Then the shoe forms inside a special type of 3-D printer.

When you're done with the shoes, an industrial composting facility can break down the material.

Both Amarasiriwardena and Clark note that the best way to make fashion more sustainable is to make fewer items and to use each one longer. So using recyclable materials to 3-D print only what we need — and would use a lot — could make fashion “greener.”

Eventually, as 3-D printing gets less costly, “a lot of things will be made at your house,” Clark predicts. He foresees a trend where people will create their own brands, developing true “ready to wear” fashion at home.

ROBOTS DO YOUR CHORES

“Hi, Robot,” says Chelsea Finn. “Can I have a sandwich with roast beef and cheese, please?” Finn is a co-founder of Physical Intelligence (PI for short), a company based in San Francisco, Calif. Standing in her lab, she's watching a set of robot arms dutifully pick up bread, meat and cheese.

3-D printed shoes like these can be made to fit someone's feet perfectly, even if the two feet are different sizes.

But they can already provide clothing that's custom-made for your body. One example is a sweater that can keep you warm without making you sweat too much. To customize your sweater, you stand in front of cameras that detect body heat. That's how “[we] figure out where the hotspots are,” says Amarasiriwardena. Then the machines weave thinner areas of material over those spots.

You can also step on a pad that figures out how your foot presses down as you walk. That info can be directed to a 3-D printer that can put cushioning into socks where you need it. Some parts of those socks also contain a fiber made from coffee grounds, which absorbs stinky smells. “We put it particularly in the sweaty areas,” says Amarasiriwardena.

You'll need some shoes to go with those anti-stink socks. Our feet are “all different shapes,” observes Asher Clark. A shoemaker, he co-founded Vivobarefoot. It's based in London, England. This

Floor-scooting robots that vacuum up lint and crumbs have been helping some families with their chores for more than 20 years. But until recently, robots could only perform very specific jobs. What most of us really want, though, are robots that can help with just about any chore we give them.

“Laundry is one thing that I don’t want to do,” says Lucy Shi. She’s a researcher at Stanford University in California who also works at PI. Unfortunately, laundry is one of the most robot-unfriendly tasks out there.

There are just so many ways clothes can be “crumpled and folded on top of themselves,” Finn explains.

In 2024, her company announced a new artificial-intelligence model, called pi-zero. It “allows a robot to do lots of different things,” she says, “not just one very specific thing.” That AI model even directed some impressive robot laundry-folding.

Pi-zero uses a form of machine learning to predict how a robot should move to accomplish some task. The model can even control different types of robot bodies, Shi notes.

In order to interact with us at home, though, robots need to be able to communicate with us. Hi Robot, which PI debuted in 2025, is a different AI model. It can interpret someone’s simple, spoken instructions and translate them into actions that the pi-zero model can then direct a robot to take.

In the sandwich-making example, Hi Robot turns Finn’s request into a series of tasks: Pick up one slice



of bread. Place it on the cutting board. Pick up one slice of roast beef. Put it on the bread. Plenty more steps will follow.

But that’s not all. Hi Robot can handle interruptions.

“In the real world, there are all kinds of unexpected things,” says Shi. When someone gives a robot feedback, it has to be able to “react to it on the fly,” she says. Hi Robot can. When Finn interrupts the sandwich-making process to ask for a slice of tomato, the robot stops and adds it to the sandwich.

AVOID GETTING SICK

Many people already wear a smartwatch or ring. Its sensors can track your temperature, heart rate, steps and more. If you’ve been sitting too long, it may remind you to stand up and move around. If you’re moving around a lot, it may ask if you want it to log a workout. Soon, these devices could tell you even more.

If you’re getting sick, for instance, a smart device might know before you do.

Peter Cho and Karnika Singh are biomedical engineers at Duke University in Durham, N.C. They’re studying how smart devices might help sense illness.

During the COVID-19 pandemic, Singh’s group found, using smartwatch data, that heart rates got higher five to 10 days before a positive COVID test. And five days before that positive test, people were already taking fewer steps than usual.

In another test, Duke researchers found that smartwatch data could reveal whether someone would have severe or mild cold symptoms. And those data could predict this 12 hours before symptoms emerged.

Sensor data alone can’t diagnose disease. But such warnings could trigger an alert. It might encourage the wearer to put on a mask or get tested.

When Chelsea Finn interrupted this robot mid-sandwich to ask for tomatoes, Hi Robot was able to change its plan.

Hi Robot can interpret a person’s simple, spoken instructions and translate them into actions — in this case, to make a sandwich. But there’s room for improvement. Hi Robot can’t yet spread mustard or mayonnaise.

READ MORE

Welcome to the Future: Robot Friends, Fusion Energy, Pet Dinosaurs, and More!

By Kathryn Hulick
Illustrated by Marcin Wolski

Robots in the kitchen and a 3-D-printable wardrobe are just the beginning. Find out more about teleportation, pet dinosaurs and more in this book.





Smartwatch alerts might even help prevent another pandemic, says Märt Vesinurm. He's a health care researcher at Aalto University in Espoo, Finland.

During the COVID-19 pandemic, people often spread disease before they felt ill. If devices had warned someone during this time, they'd have "cut that spreading by quite a lot," he says. To gauge how much, he and some U.S. colleagues teamed up to measure how much a watch's early warning might help.

They found that early warnings had the potential to cut disease spread by some 40 to 65 percent. This points to "the revolutionary potential of smartwatches to manage seasonal diseases — and alter the course of future pandemics," they concluded in 2025 in *PNAS Nexus*.

NO NEED FOR BATTERIES

Hologram glasses, sandwich-making robots, 3-D printers and health-tracking watches all need one thing: power. Today's smart devices all contain bulky batteries for power. When you forget to charge that battery, you end up with a dead device.

In the future, "wearables and small sensors could run on energy from body heat or motion," says Mohammad Malakooti. He's an engineer at the University of Washington in Seattle. His team invented such a device.

The soft, stretchy, durable device relies on thermoelectric materials. When these are exposed to heat on one side — and cold on the other side — they turn the heat into electricity. Malakooti showed in 2024 that the device can harvest body heat to make enough electricity to power an LED light.

He started working on it in the late 2010s when he was at Carnegie Mellon University in Pittsburgh, Pa. At the time, Mason Zadan worked with him.

Over the next few years, Zadan took the same idea in a different direction. Also in 2024, he and another team of researchers at Carnegie Mellon made a version that powers a wearable sensor that measures heart rate and other factors related to heart health.

These devices generate very tiny amounts of power. They can't come close to charging a smartphone (or a pair of hologram glasses).

Other futuristic materials make electricity when they are stretched or squished or rubbed. So these might turn different types of motion into power. "In the future, I would hope that we can use a combination of these approaches," Zadan says. Then, maybe, we could "replace batteries altogether," he says.

These five technologies are just a small sample of the ideas engineers are working on to transform our world. Each might take years — even decades — to reach store shelves. So you might be one of the engineers or designers who helps turn these futuristic visions into reality. ▶

Stretchy, bendable electricity generators could one day be integrated into clothing or wearable sensors.



The arm band Mason Zadan (right) is wearing contains materials that convert body heat into electricity. Zadan tested how well this worked during everyday activities, such as running on a treadmill.

This engineer designed a device to make farm work easier

Juan Espinoza is looking to automate agriculture — and maybe one day help you buy a car

Mechanical engineer Juan Espinoza's work in agriculture runs deep. In the 1990s, his parents immigrated to California from Mexico. With little formal education, they could only find work picking crops such as almonds, grapes and roses. When Espinoza and his siblings reached working age — that was 15 for Espinoza — his parents required them to pick crops for at least one summer. “They wanted to teach their children the value of a dollar,” he says. “They wanted us to aspire for more.”

That experience inspired his work as an engineer. Improper picking can damage fruit, he had noticed, making it less valuable. Espinoza, now at California State University, Fresno, designed a device called an end effector for a citrus harvesting machine. Found at the end of robotic arms, this device acts like mechanical hands. It includes both a gripper and a cutter. The cutter employs the specialized shears farmworkers use to cut stems. The gripper delicately grips the fruit. “I got to combine the things I learned in the classroom with my personal experience,” he says.

The device could help farmers and workers alike. Working in California's intense summer heat leaves laborers at risk of heat-related illnesses and injury, he notes. Farmers are also struggling to find laborers. Espinoza hopes his citrus harvester can help with worker shortages as well as ease the physical demands on farmworkers. In this interview, he shares his experiences with *Science News Explores*. (This interview has been edited for content and readability.) — Aaron Tremper

Q What inspired your love for engineering?

A My interest in mechanical engineering came from growing up around vehicles. I had a lot of older family members who were into the '90s Honda scene. They would buy older vehicles and fix them up. Paint them, install sound systems, swap engines. My cousins and I would all hang out and go to car meets together.

Q What was a big challenge that you faced?

A Being a first-generation student. [A first-generation student is one who is in the first generation of their family to attend a college or university.] I never had anybody in my family who knew how to navigate higher education. My parents and siblings would give me advice that came from the heart. They meant well, but they didn't have the actual experience. I had to figure it out on my own.

Q How has agricultural tech changed?

A Historically, mechanical systems have been simple, robust and reliable. And repairing these systems was very simple and straightforward. If something broke, the farmer was the one to fix it. Now, they can't fix broken machines. The “right to repair” has been a huge topic across different sectors of tech. Did you know, when something breaks on your iPhone, you cannot buy or install an authentic Apple part directly as a consumer? You must either go through a third party or take it to Apple to fix.

Q What's next for you?

A Agricultural tech was never really a career aspiration of mine. I enjoy it and do it now because it adds to an industry that got me to where I am today. Thanks to agriculture, my parents could provide for us and I could get an education. My passion, though, is in automobiles. I want to provide people with reliable vehicles that are inexpensive to fix.



As a graduate student, Juan Espinoza designed an automated device that makes citrus picking easier. Improper picking can damage fruit, making it less valuable. To prevent this, the device gently grasps the fruit with its clawlike gripper. A cutter then severs the stem right where it meets the fruit.

EARTH

Build your own seismograph

This type of tool measures the strengths of earthquakes

By Science Buddies

A seismograph is a tool that records earthquakes and measures their strengths. That helps scientists better understand — and hopefully one day predict — quakes. In this activity, make your own seismograph with simple materials.

OBJECTIVE

Build a seismograph

EXPERIMENTAL PROCEDURE

1. Cut the lid off a box and stand it up so that its open side faces forward.
2. Poke two holes opposite each other near the rim of a paper cup. Tie a string to each hole.
3. Poke two holes in the top of the box the same distance apart as those in the cup.
4. Push the strings through the holes and tie them together atop the box. The bottom of the cup should hang 2.5 centimeters (1 inch) above the box's bottom.
5. Poke a hole in the bottom of the cup and push an uncapped marker through it. The marker's tip should touch the bottom of the box.
6. Fill the cup with coins to hold the marker in place.
7. Cut slits near the bottom edges of the left and right sides of the box.
8. Have a helper slowly start to pull a long receipt through one slit, across the middle of the box beneath the marker, and out the other slit.
9. Shake the box back and forth perpendicular to the receipt as your helper pulls it.
10. Pause your shaking for a few seconds as your helper continues to pull the receipt. Then, shake the box harder.
11. Repeat Step 10, but shaking the box more gently.
12. How does the line on the receipt change over Steps 9–11?



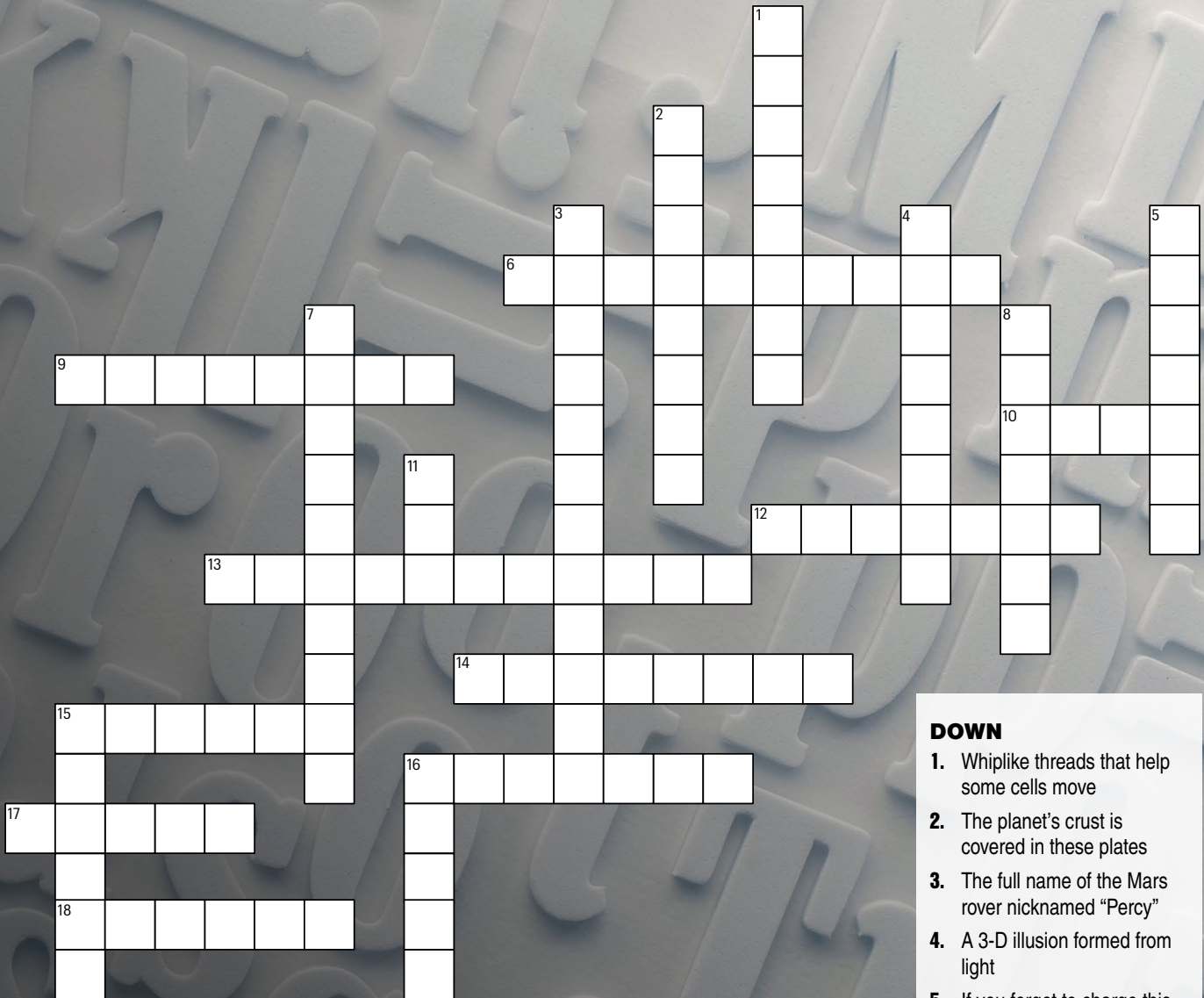
Find the full activity, including a how-to video, at snexplores.org/seismograph. This activity is brought to you in partnership with Science Buddies.



When the ground shakes during an earthquake, a seismograph records the motion of its base as it shifts back and forth beneath a hanging weight.

Crossword

If you're having trouble figuring out the answers to the clues below, make sure you read all the stories in this issue. Check your work by following the QR code at the bottom of the page.



ACROSS

- 6. This device can be used to push air through a person's lungs
- 9. The Chicago "rat hole" was probably made by one of these animals
- 10. Earth has inner and outer versions of this
- 12. The Earth's mantle has this candy's texture
- 13. This device can be used to measure earthquakes
- 14. *Nanotyrannus* is one of these
- 15. This kind of torch is the closest thing we have to a lightsaber
- 16. This stone helped archaeologists decipher Egyptian hieroglyphs
- 17. You might have one of these cleaning the floors of your home
- 18. This element turns your blood bright red

DOWN

- 1. Whiplike threads that help some cells move
- 2. The planet's crust is covered in these plates
- 3. The full name of the Mars rover nicknamed "Percy"
- 4. A 3-D illusion formed from light
- 5. If you forget to charge this, you may end up with a dead device
- 7. This is the "A" in AI
- 8. An accident at this kind of power plant can release deadly radiation
- 11. ChatGPT is a type of this (abbreviation)
- 15. A massless, chargeless particle of light
- 16. Breathing in this radioactive element can increase a person's cancer risk



HUMANS

Passing gas up the bum might help people breathe

The idea might sound wild, but don't poo-poo it — animal studies hint it just might work

Takanori Takebe is on a mission to find out if people can breathe through their butts.

The physician and scientist's quest to explore backside breathing began several years ago when his father caught pneumonia. Doctors had to put a tube down his dad's throat so that a ventilator could push air into his lungs.

"I was really shocked by how invasive it is," says Takebe. He works at Cincinnati Children's Hospital Medical Center in Ohio and the University of Osaka in Japan.

Takebe worried about how the ventilator might affect his dad, who had already lost part of one lung due to a past infection. Takebe also was concerned about his father's lack of other treatment options. That got him curious: Was there any way to get oxygen into the body without the lungs?

One day, a student showed Takebe a book that described how some animals get oxygen through their skin or guts. Fish called loaches, for example, can swallow air and absorb oxygen through their intestines.

Takebe knew that the human intestinal tract is rich in blood vessels. That's why treatments called enemas — which send liquid up a patient's bottom — can get medicine into the bloodstream. And it made Takebe suspect that oxygen could pass from the intestines into the bloodstream, too.

GUT CHECK

Takebe's team devised an enema-like treatment. It sends a liquid called perfluorodecalin up the rectum. This liquid can be loaded up with oxygen. As it releases that oxygen into the body, space opens within its chemical structure to absorb "exhaled" carbon dioxide.

The scientists first tested this in mice and pigs. The liquid did help animals survive low-oxygen conditions.



COURTESY OF CINCINNATI CHILDREN'S HOSPITAL MEDICAL CENTER

Freshwater fish called loaches, which can absorb oxygen through their intestines, inspired the butt-breathing technique.

Pigs got 400-milliliter doses. (That's slightly more liquid than a 12-ounce can of soda.) Each dose boosted pigs' oxygen levels for about 19 minutes.

During these experiments, Takebe recalls seeing samples of the pigs' blood change color. It shifted from a muddy, low-oxygen hue to a brighter, oxygen-rich red. "That was my aha moment," Takebe says. His wild idea just might work.

Now, Takebe's group has tested the safety of butt breathing in people. Twenty-seven healthy men in Japan volunteered to take a dose of perfluorodecalin up the anus. They were asked to hold it in their guts for an hour.

Volunteers got different doses. The smallest was a squirt of 25 milliliters (about 5 teaspoons). The biggest was a whopping 1.5 liters (about 1.5 quarts). That's the most allowed for other medical procedures that send liquid up the bum.

Four of the six men in the 1.5-liter group had to stop receiving liquid early. It hurt their stomachs too much. But most of those who got up to 1 liter fared pretty well. Their worst complaints were bloating and mild tummy pain.

These findings, published in *Med*, hint that the treatment could be safe for people. But future studies will have to show whether it actually gets oxygen into the bloodstream.

SAFE, BUT SENSIBLE?

Doctors and scientists have mixed reactions to this research.

One serious skeptic is John Laffey. He's a doctor and scientist who specializes in lung failure. He works at the University of Galway in Ireland.

Even if people can get oxygen through the intestines, it wouldn't be practical, Laffey says. "A liter of perfluorodecalin carries 500 milliliters of oxygen," he says. "We use 250 milliliters per minute." So sustained oxygen support would require many enemas, over and over.

Kevin Gibbs is more intrigued by the treatment. He's a critical-care lung doctor at Wake Forest University School of Medicine in Winston-Salem, N.C.

"It definitely raised my eyebrows," Gibbs says of the butt-breathing idea. But sending oxygen in the back entrance — if it works — could be useful in a few cases, he thinks.

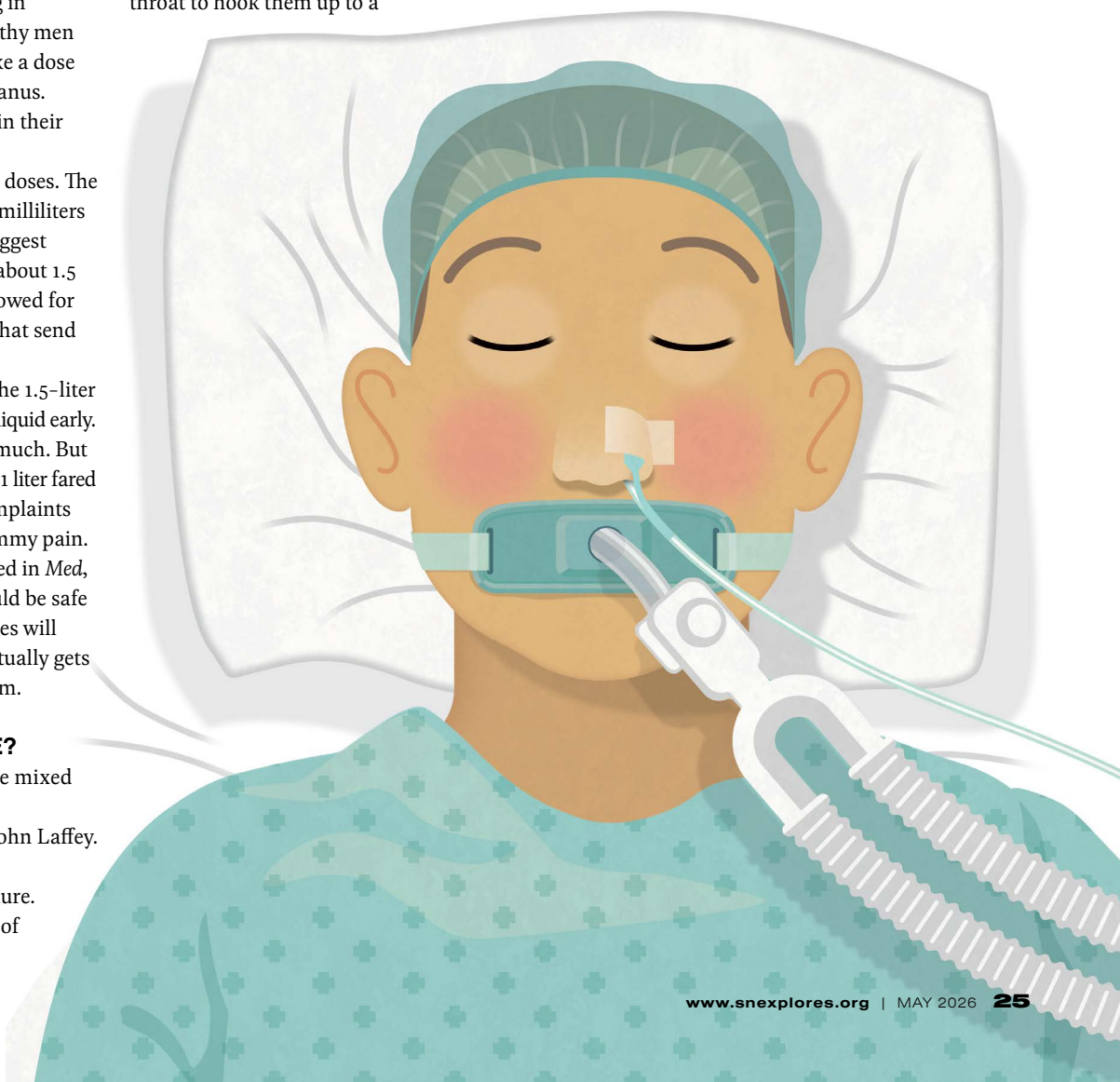
One example is when doctors need to put a tube down someone's throat to hook them up to a

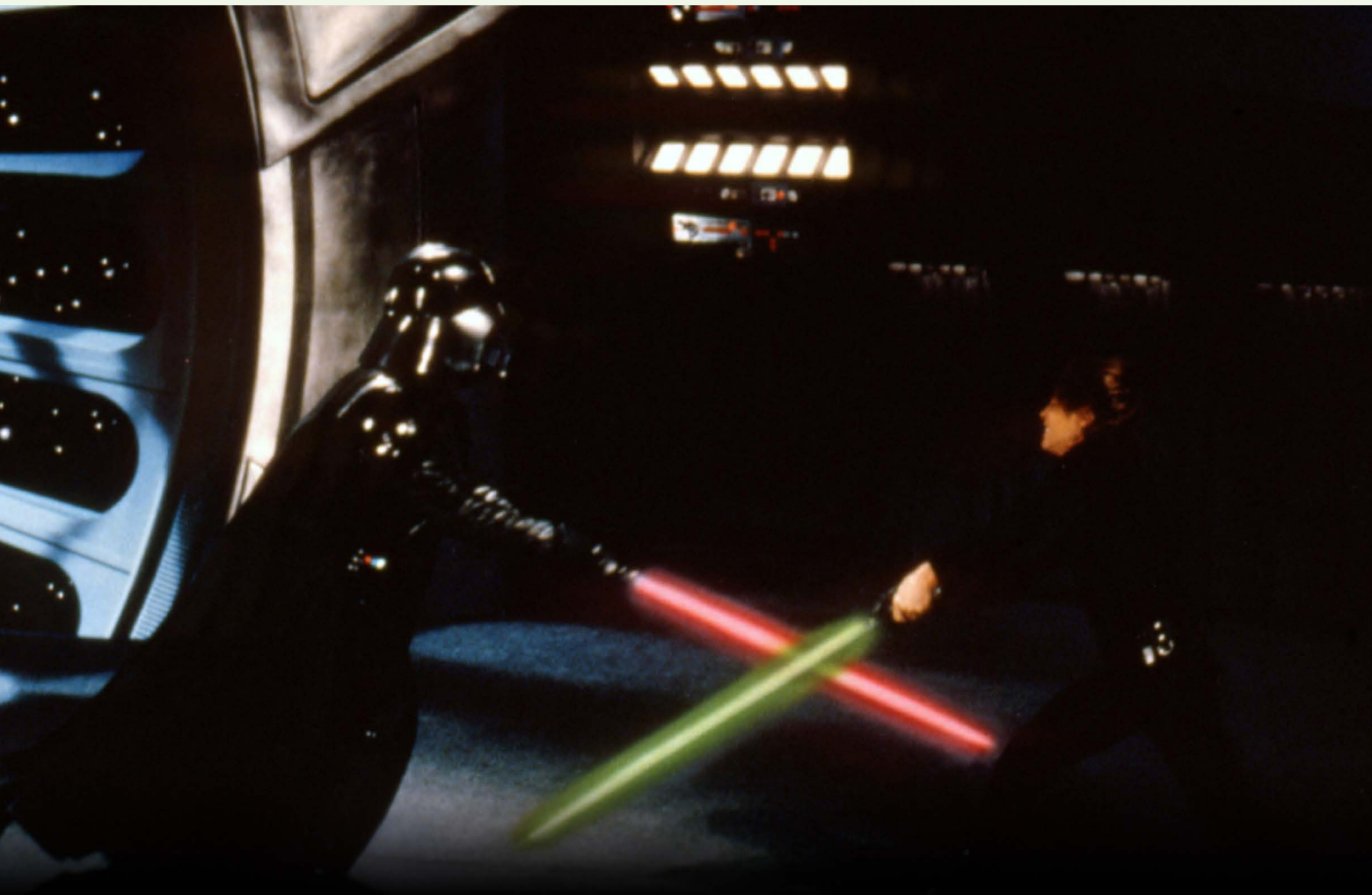
ventilator. In the minutes that takes, patients can suffer dangerously low oxygen levels, Gibbs says. Sending oxygen up the anus might sustain patients for the short time it takes to get them on life support. "That would be huge," he says.

Takebe imagines butt breathing could also be a short-term solution when other treatments aren't available. For instance, when someone is on the way to the hospital.

How does Takebe's father feel about butt breathing as a way to help patients like him? "Dad is pleased," Takebe says. "He's always offering to be our experimental subject." That would be a conflict of interest, Takebe adds. But he appreciates the support. — Maria Temming

Takanori Takebe (left) developed the butt-breathing approach after seeing his dad put on a ventilator in the hospital. Ventilators push air into someone's lungs through a face mask over their mouth and nose or a tube placed down their throat (below).





PHYSICS

Could a *Star Wars* lightsaber work?

Plasma torches are the closest things we have to real lightsabers, but don't try dueling with them

In a galaxy far, far away, two lightsabers buzz with energy. A pair of enemies swing their weapons toward one another. As their blades clash, tiny sparks fly off.

Star Wars lightsabers are perhaps the coolest gadgets in science fiction. These high-energy weapons can melt, cut and burn through almost anything — and with minimal resistance. But

when one lightsaber meets another, they clash against each other, blade against blade, creating epic duels.

A lightsaber may be a great weapon to wield if you're a Jedi or Sith, but could one exist in the real world? It turns out that making a beam of light behave like a solid sword is far, far trickier than it looks on the big screen.

PASSING THROUGH

These weapons have no real-world equivalent. They have been hypothesized to be made from plasma or, sometimes, lasers. Plasma is extremely hot gas that becomes electrically charged. Lasers produce highly focused beams of light.

Both lasers and plasma face the same fundamental problem in

Real-world physics has no way to create weapons like the lightsabers wielded by Jedi Knights and Sith Lords in *Star Wars*.

SCREENPROD/PHOTONISTOP/ALAMY

re-creating one of the lightsaber's signature effects: They can't smash into things like solid objects.

Consider something solid, such as a tennis ball. When tennis balls collide, they bounce off each other because the atoms in one ball push against the atoms in the other.

A laser, though, is made of photons. These are the massless, chargeless particles that make up light. When one beam of photons meets another, they pass through each other. Imagine trying to duel with a pair of flashlights — the beams would just pass through each other.

Plasma faces a similar problem. While made of matter, plasma consists of charged particles. These could be shaped by magnetic fields into a glowing, lightsaber-shaped column. However, without some extraordinary circumstances, this plasma would still behave like a gas.

"Having a sword battle with two plasma torches would be just as effective as having a battle of air columns from two leaf blowers. The columns of gas or plasma would just go right through each other," says physicist David Schaffner. He studies plasma physics at Bryn Mawr College in Pennsylvania.

WHAT WOULD IT TAKE?

In 2019, physicists Jean-Sebastien Gagnon and François Fillion-Gourdeau explored the possibility of lightsabers in a study published in the *European Journal of Physics*. Gagnon works at Norwich University in Northfield, Vt. Fillion-Gourdeau works in Canada at Infinite Potential Laboratories in Waterloo, Quebec.

Light-based lightsabers using extremely powerful lasers could theoretically work, they calculated. With the right conditions, two lightsaber blades could feel solid to each other and clash like in the movies. However, the laser intensities and energy levels needed are unrealistic.

Running such a lightsaber for just one minute would need about

one-thousandth of the sun's total power output in one second, they found. That would take fuel weighing about 10 times Egypt's Great Pyramid of Giza.

Plasma might work better. But it faces its own challenge: containment.

Creating plasma requires energy to first rip electrons from atoms. To stay stable in open air, though, plasma must maintain super-high temperatures. And that would take a huge amount of energy.

"It's like trying to keep soup boiling in a snowstorm. The heat leaks into the surrounding air incredibly fast," explains Jhovanna Garcia. She studied nuclear engineering at the University of Tennessee, Knoxville. Like boiling that soup, keeping plasma stable is possible. It just takes a lot of energy. She equates it to running 1,000 toasters at once.

Scientists have found a workaround using a technique called Z-pinch. Here, powerful electric currents create magnetic fields. These fields squeeze plasma into shape. They also maintain the required temperatures.

Despite this workaround, there is another problem: practicality. Current plasma-containment devices only work inside sealed vacuum chambers. In open air, plasma would instantly cool down and disappear.

REALITY STRIKES BACK

Plasma torches are the closest devices we have to a real lightsaber. This torch produces a hot, highly directed flow of plasma that can slice through various materials, including aluminum and stainless steel. Welders use them to fuse or cut metals in factories and workshops.

But plasma torches don't measure up to movie lightsabers.

The beams produced by a plasma torch are only several centimeters (a few inches) long. Plasma torches also need cables and wires to supply a constant stream of gas and electrical power. This makes them impossible to wield like a sword.

Most importantly, the "blades" would simply pass through each other rather than clashing dramatically.

So while we won't see any real Jedi and Sith with glowing lightsabers, plasma research continues to advance. This brings us closer to understanding the limits of physics.

Until then, the fiction will have to remain strong with the movies.
— Tejasri Gururaj

Plasma torches are often used to cut or weld metals.



EARTH

Delve into our planet's layers

Sizzling heat, unimaginable pressure and surprise diamonds — it's all there, deep beneath us

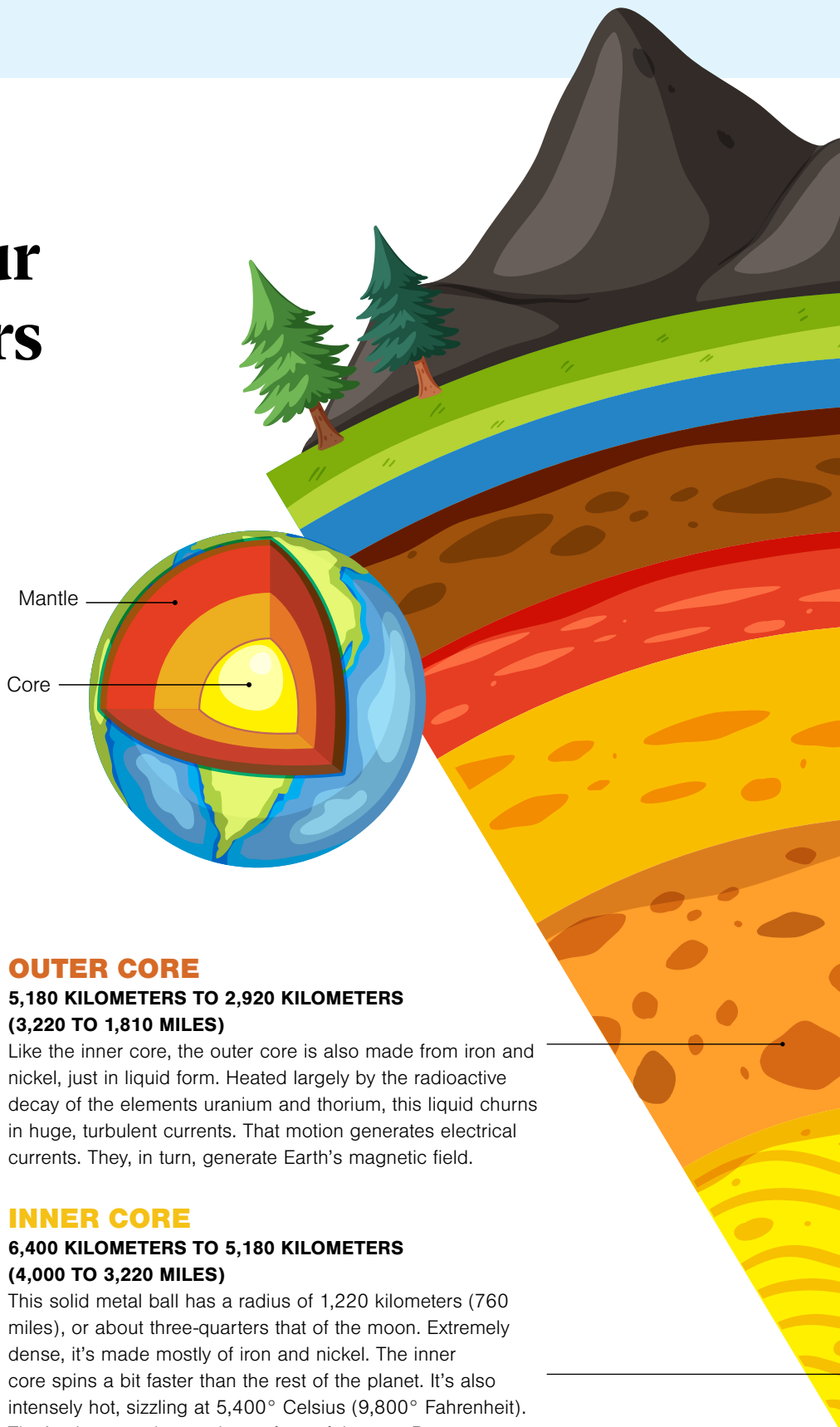
Earth's surface is an amazing place to behold. Yet even the deepest canyon is but a tiny scratch on the planet. To really understand Earth, you need to travel nearly 6,400 kilometers (4,000 miles) beneath our feet.

Starting at the center, Earth is composed of four distinct layers. Except for the crust, no one has ever explored these layers in person. In fact, the deepest humans have ever drilled is just over 12 kilometers (7.6 miles). And even that took 20 years!

Still, scientists know a great deal about Earth's inner structure. They've plumbed it by studying how earthquake waves travel through the planet. The speed and behavior of these waves change as they encounter layers of different densities. Scientists — including Isaac Newton, three centuries ago — have also learned about the core and mantle from calculations of Earth's total density, gravitational pull and magnetic field.

Here's a primer on Earth's layers, starting with a journey to the center of the planet.

— Beth Geiger



OUTER CORE

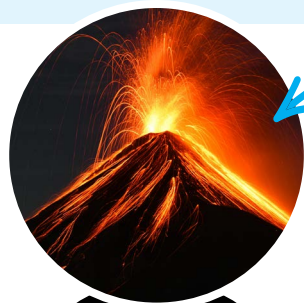
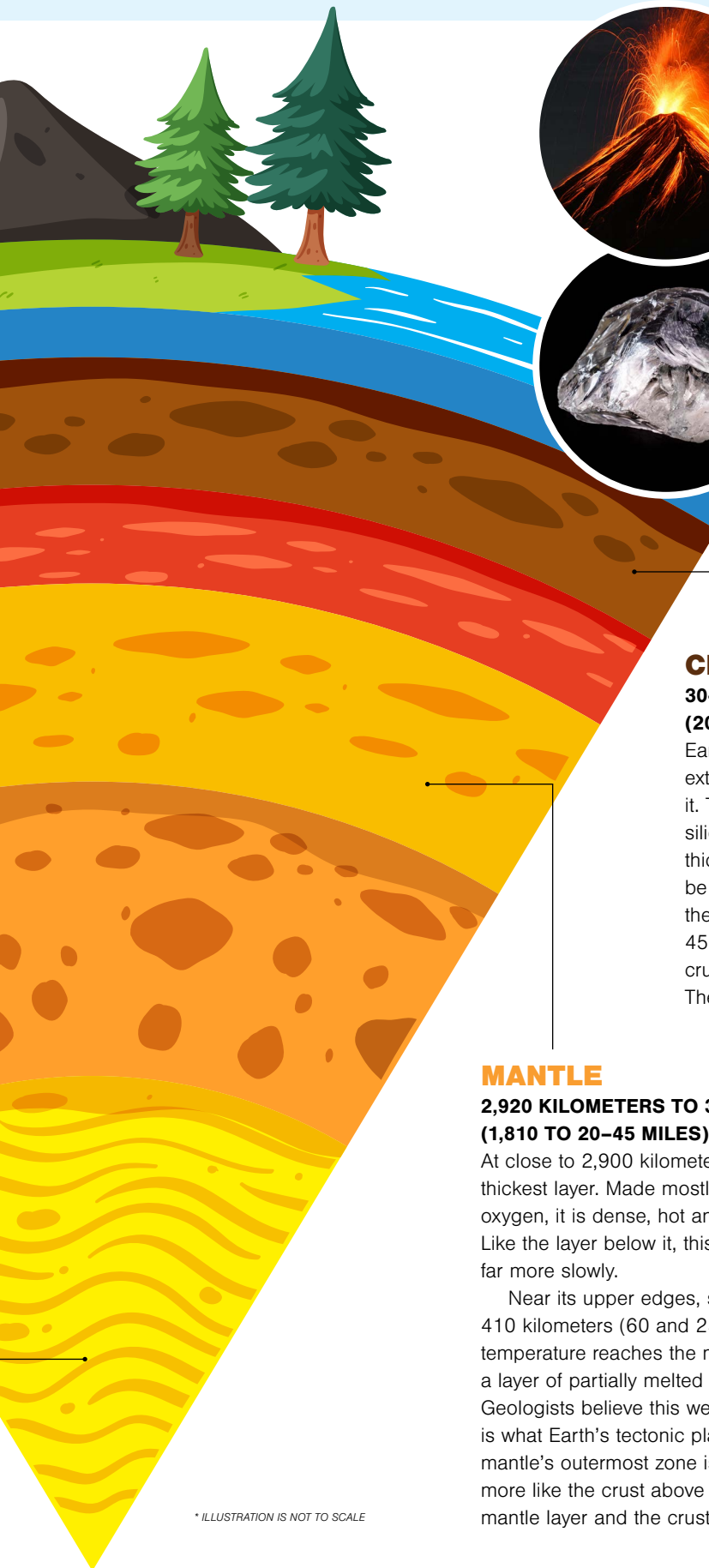
**5,180 KILOMETERS TO 2,920 KILOMETERS
(3,220 TO 1,810 MILES)**

Like the inner core, the outer core is also made from iron and nickel, just in liquid form. Heated largely by the radioactive decay of the elements uranium and thorium, this liquid churns in huge, turbulent currents. That motion generates electrical currents. They, in turn, generate Earth's magnetic field.

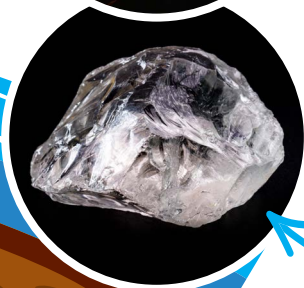
INNER CORE

**6,400 KILOMETERS TO 5,180 KILOMETERS
(4,000 TO 3,220 MILES)**

This solid metal ball has a radius of 1,220 kilometers (760 miles), or about three-quarters that of the moon. Extremely dense, it's made mostly of iron and nickel. The inner core spins a bit faster than the rest of the planet. It's also intensely hot, sizzling at 5,400° Celsius (9,800° Fahrenheit). That's almost as hot as the surface of the sun. Pressures here reach well over 3 million times greater than on Earth's surface. Some research suggests there may also be an inner, inner core. It would likely consist almost entirely of iron.



Most earthquakes, volcanoes and mountain ranges result from the movements of tectonic plates.



Diamonds are tiny pieces of the mantle we can actually touch. These crystals are brought to the surface in volcanic rock known as kimberlite.

CRUST

**30–70 KILOMETERS TO 0 KILOMETERS
(20–45 TO 0 MILES)**

Earth's crust is like the shell of a hard-boiled egg. It is extremely thin, cold and brittle compared to what lies below it. The crust is made of relatively light elements, especially silica, aluminum and oxygen. It's also highly variable in its thickness. Under the oceans (and Hawaiian Islands), it may be as little as 5 kilometers (about 3 miles) thick. Beneath the continents, the crust may be 30 to 70 kilometers (20 to 45 miles) thick. Along with the upper zone of the mantle, the crust is broken into big pieces, like a gigantic jigsaw puzzle. These are known as tectonic plates.

MANTLE

**2,920 KILOMETERS TO 30–70 KILOMETERS
(1,810 TO 20–45 MILES)**

At close to 2,900 kilometers (1,800 miles) thick, this is Earth's thickest layer. Made mostly of iron, magnesium, silicon and oxygen, it is dense, hot and semi-solid (think caramel candy). Like the layer below it, this one also circulates. It just does so far more slowly.

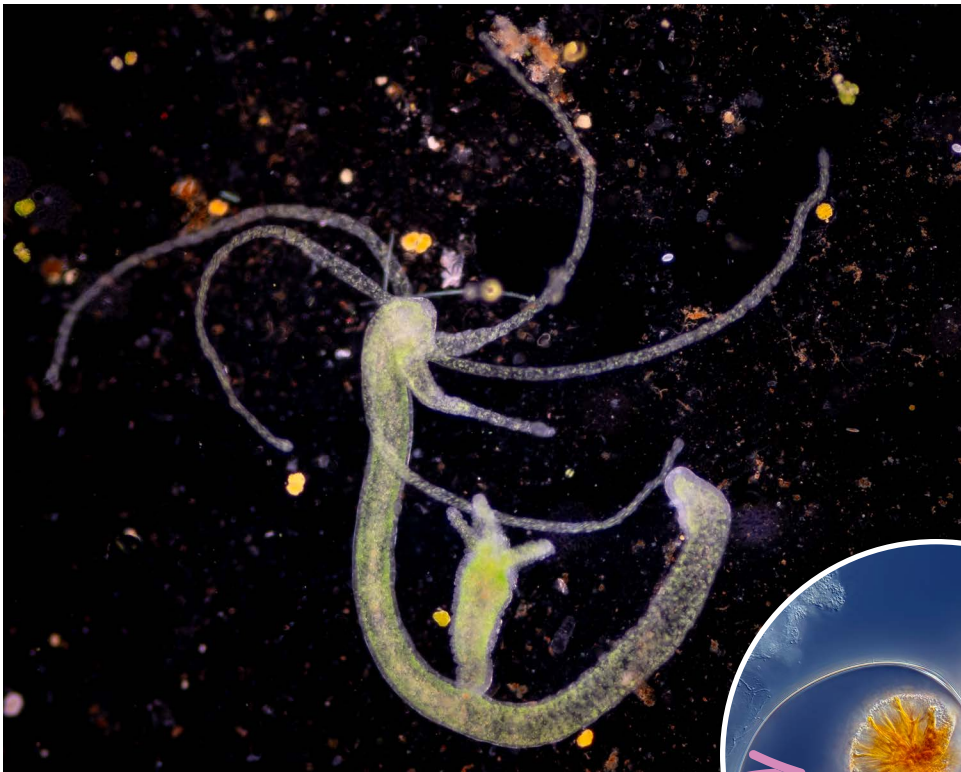
Near its upper edges, somewhere between about 100 and 410 kilometers (60 and 250 miles) underground, the mantle's temperature reaches the melting point of rock. Indeed, it forms a layer of partially melted rock known as the asthenosphere. Geologists believe this weak, hot, slippery part of the mantle is what Earth's tectonic plates ride upon and slide across. The mantle's outermost zone is relatively cool and rigid. It behaves more like the crust above it. Together, this uppermost part of the mantle layer and the crust are known as the lithosphere.

* ILLUSTRATION IS NOT TO SCALE

LIFE

Some cells are real speed demons

Cells move fast by jumping, gliding, swimming and expanding



Tiny freshwater creatures known as hydra (one pictured) have stinging cells that swiftly shoot out a threadlike structure.

Life in the fast lane may call to mind sprinting cheetahs and diving falcons. But there are plenty of speed demons barely visible to the naked eye. Some of the fastest living things are cells. If these cells competed in their own Olympics, who would win? Scientists have now worked out how some of the world's smallest swimmers, sprinters and jumpers would stack up.

Competitors in the cellular Olympics wouldn't show up dressed in their uniforms and ready to compete, says Manu Prakash. He's a bioengineer and oceanographer at Stanford University in California. "We have to go search in puddles and ponds

Pyrocystis algae make the longest migration on the planet relative to their size.

around the world and in the deep ocean," he says. To compare the cells, his team collected speed data on some and reviewed past data on others.

Some swift cells jump or glide across water. Others flail whiplike threads called flagella or swim with the help of hairlike cilia. Then there

are speedsters that don't change position but shrink or expand. A cell that's part of a larger organism can make a rapid move. That includes the stinging cells of freshwater hydra, which fire off toxins. Single-celled life forms can also move in a flash.

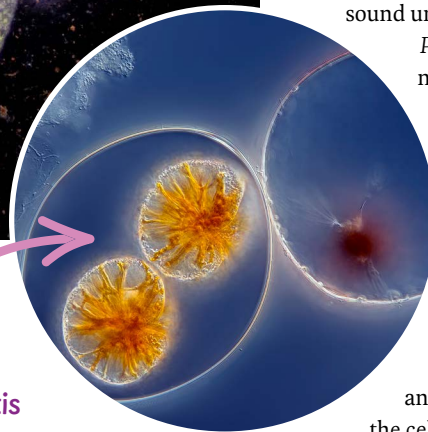
On a trip to Liberia, in West Africa, Prakash saw specks of white in a pond. He scooped out a sample and found *Spirostomum*, a type of single-celled organism. Shrinking its body super fast is part of *Spirostomum*'s communication, Prakash says. "It actually talks to other cells, we discovered later, using sound underwater."

Pyrocystis algae, meanwhile, don't swim and yet make a massive migration. Prakash found these cells in the ocean off the coast of Hawai'i. His team realized that the algae could balloon to five times their original size and deflate. That allows the cells to travel about a kilometer (0.6 mile) from the depths to sunlit water.

Relative to the cells' size, that's the longest migration on the planet, Prakash says. He and teammate Ray Chang shared their findings in the *Annual Review of Microbiology*.

Prakash has found many fast cells as he's searched for life in extreme conditions. "This planet is filled with absurdities," he says. "When you're able to compare these things, you are able to understand the degree of absurdity."

— Carolyn Wilke ▀



WELCOME TO THE CELLULAR OLYMPICS!

FIGURE A

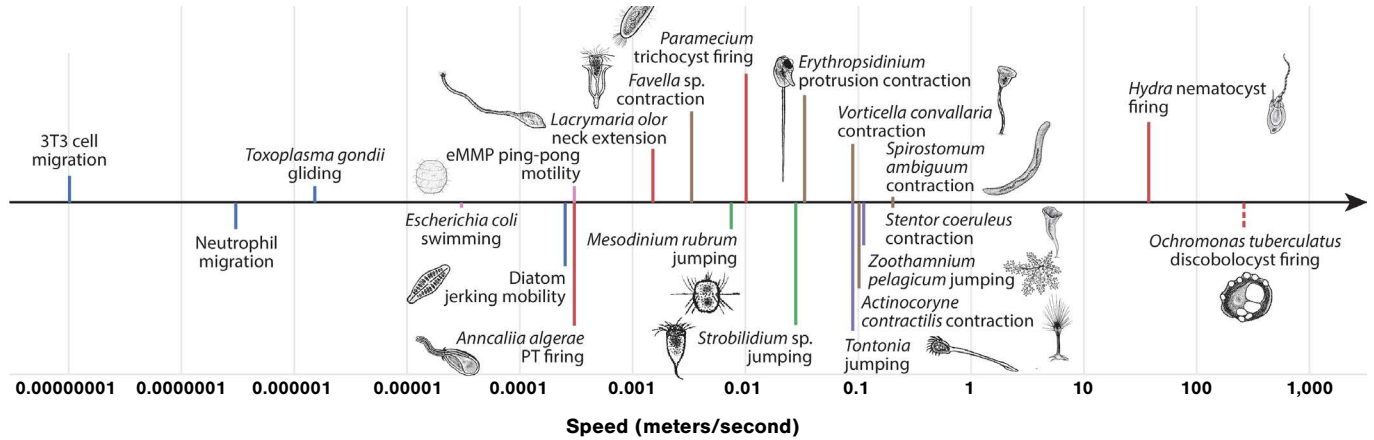


FIGURE B

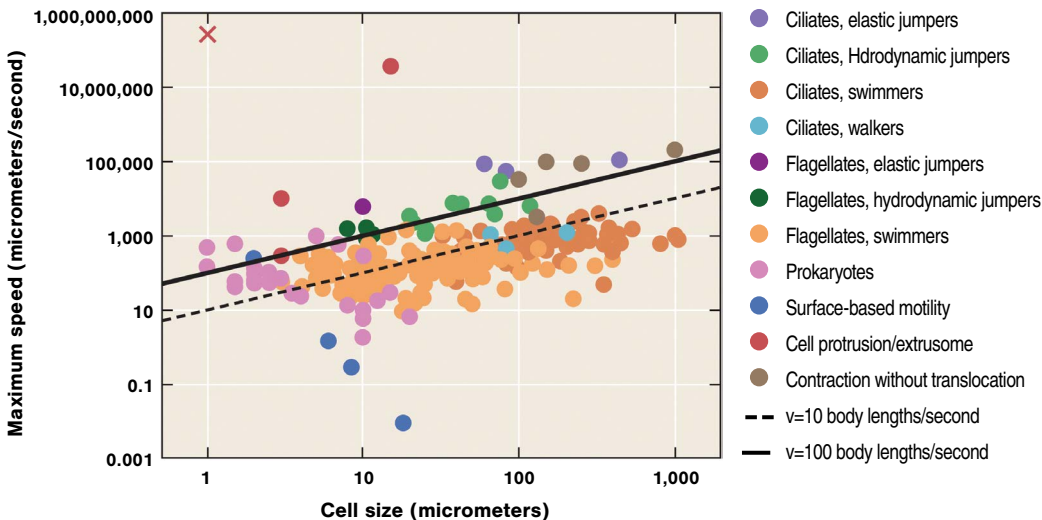


Figure A shows the speeds of some of the fastest cells known and how they move. Figure B shows different cells' size and maximum speed. Ciliates have hairlike structures called cilia. Flagellates have whiplike structures called flagella. They make many of the same types of moves, such as elastic jumping (movements by contracting cilia or flagella) or hydrodynamic jumping (using cilia or flagella to leap forward). Prokaryotes include bacteria and archaea. Surface-based motility means that a cell moves along a surface. Cell protrusion or extrusome is something popping out of a cell. Contraction without translocation means the size of the cell changes, but the cell's position doesn't. Cells above the dashed line move more than 10 body lengths per second. Cells above the solid line move faster than 100 body lengths per second.

DATA DIVE

1. What is the fastest cell shown in Figure A? What is its speed?

2. What is the fastest swimming cell? What is the fastest contracting cell?

3. Look at Figure B. How do elastic jumping ciliates compare with swimming ciliates?

4. Ultrafast cells appear above the solid line marking 100 body lengths per second. What are the most common types of ultrafast cells?

5. The "x" shows an estimate of a speed for a projectile fired off from *Ochromonas tuberculatus*. How fast does it move in body lengths per second?

ANSWER

A squirrel may have made Chicago's 'Rat Hole'

Scientists used tricks for studying fossils to identify the concrete critter crater

It may look like a rat went "splat" in this slab of a Chicago sidewalk, but a new study suggests the impression was more likely left by a squirrel.

For years, people in one Chicago neighborhood walked past an unusual sight: a hole in the sidewalk that looked as if a rat had belly-flopped into wet concrete. Now, research suggests that imprint is likely a squirrel squish.

Dubbed "Splatatouille" — a riff on the name of the Disney movie *Ratatouille* — photos of the Chicago Rat Hole went viral in 2024. Those images were key to a study published in *Biology Letters*.

Researchers borrowed methods from paleontology to figure out which modern mammal made its mark in the city.

Using dozens of images from social media, they measured the imprint's features, such as its nose-to-tail length and head width. Splatatouille's measurements most closely match those of a squirrel. Specifically, an eastern gray (*Sciurus carolinensis*) or a fox squirrel (*S. niger*).

A squirrel-like bushy tail is missing from the impression. But researchers say it's not likely that concrete would capture such fine furry detail.

There are no tracks by the imprint, which suggests the animal likely fell into the wet concrete from above. Perhaps a hawk or owl dropped the rodent. Or it may have fallen from a tree.

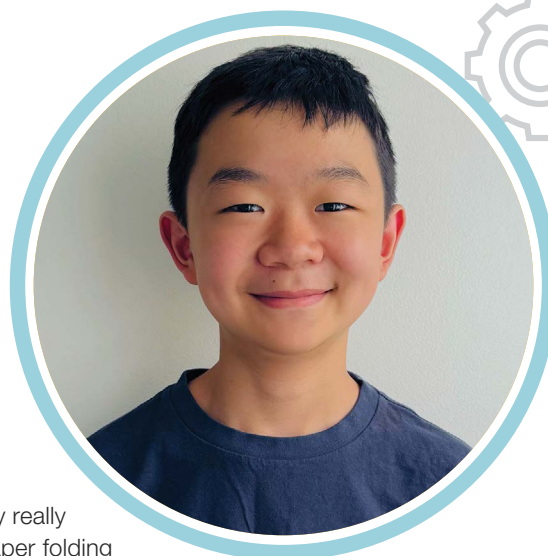
— Amanda Heidt



+ INSIDE THE MIND OF A YOUNG SCIENTIST

+ A Thermo Fisher Scientific Junior Innovators Challenge winner answers three questions about his science

Science competitions can be fun and rewarding. But what goes on in the mind of one of these young scientists? **Miles Wu**, winner of the top prize at the 2025 Thermo Fisher Scientific Junior Innovators Challenge, shares his experience.



Q What was the most rewarding part of your project?

A “Realizing that these origami patterns are actually really strong,” Miles says. He tested whether a type of paper folding called Miura Ori could support enough weight to be used to design emergency shelters. “I was really pleasantly surprised, because I didn’t think they would hold that much,” Miles says. “Halfway through my project, I realized that I would need heavier weights, so I [bought] these two really gigantic 50-pound exercise weights.” The strongest fold only collapsed under about 200 pounds!

Q What was the most difficult part?

A “The amount of time it took,” Miles says. The total time to design, fold and test each Miura-Ori pattern took around 250 hours, he estimates. “I did it a lot over school breaks,” he says. Most of the work was done in his living room. “Sometimes it felt kind of repetitive. That was the most challenging part — actually having the commitment to finish the entire project.”

Q Any advice for science fair newbies?

A “Explore hobbies and topics that you love, even if you don’t think they’re related to science fair research,” Miles says. Research projects can help you find new interests, he adds.

+ \$25,000 Thermo Fisher Scientific ASCEND (Aspiring Scientists Cultivating Exciting New Discoveries) Award

Miles Wu

Miles Wu, 14, tested how much weight Miura-Ori origami folds can support. The strongest folds held more than 9,000 times their paper’s weight. Miles hopes his research can someday be used to build pop-up emergency shelters. Miles did this project as an eighth grader at Hunter College High School in New York City.



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