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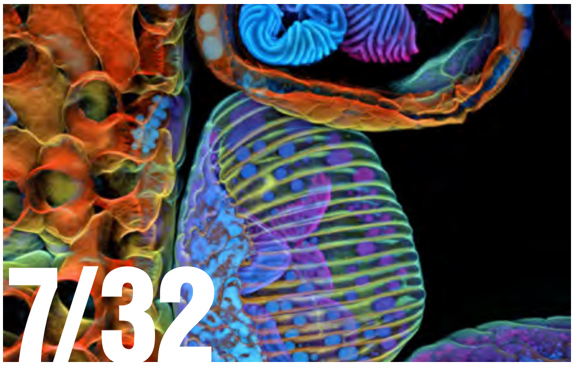

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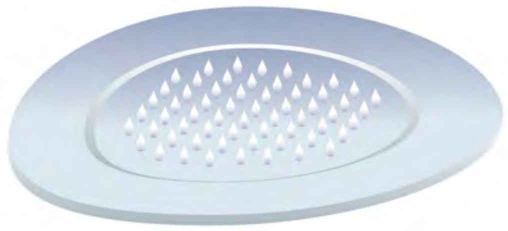

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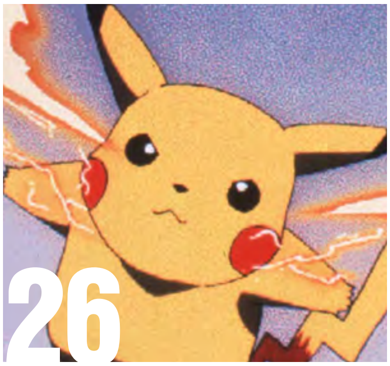

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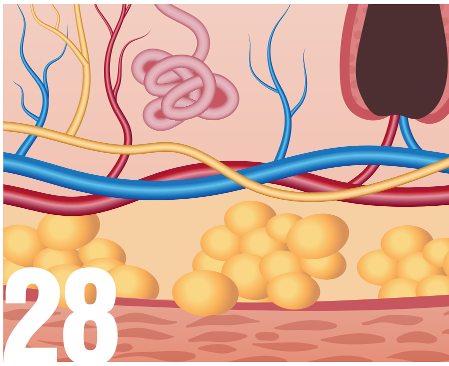

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VOYAGER: JOSHIMERBIN/SHUTTERSTOCK

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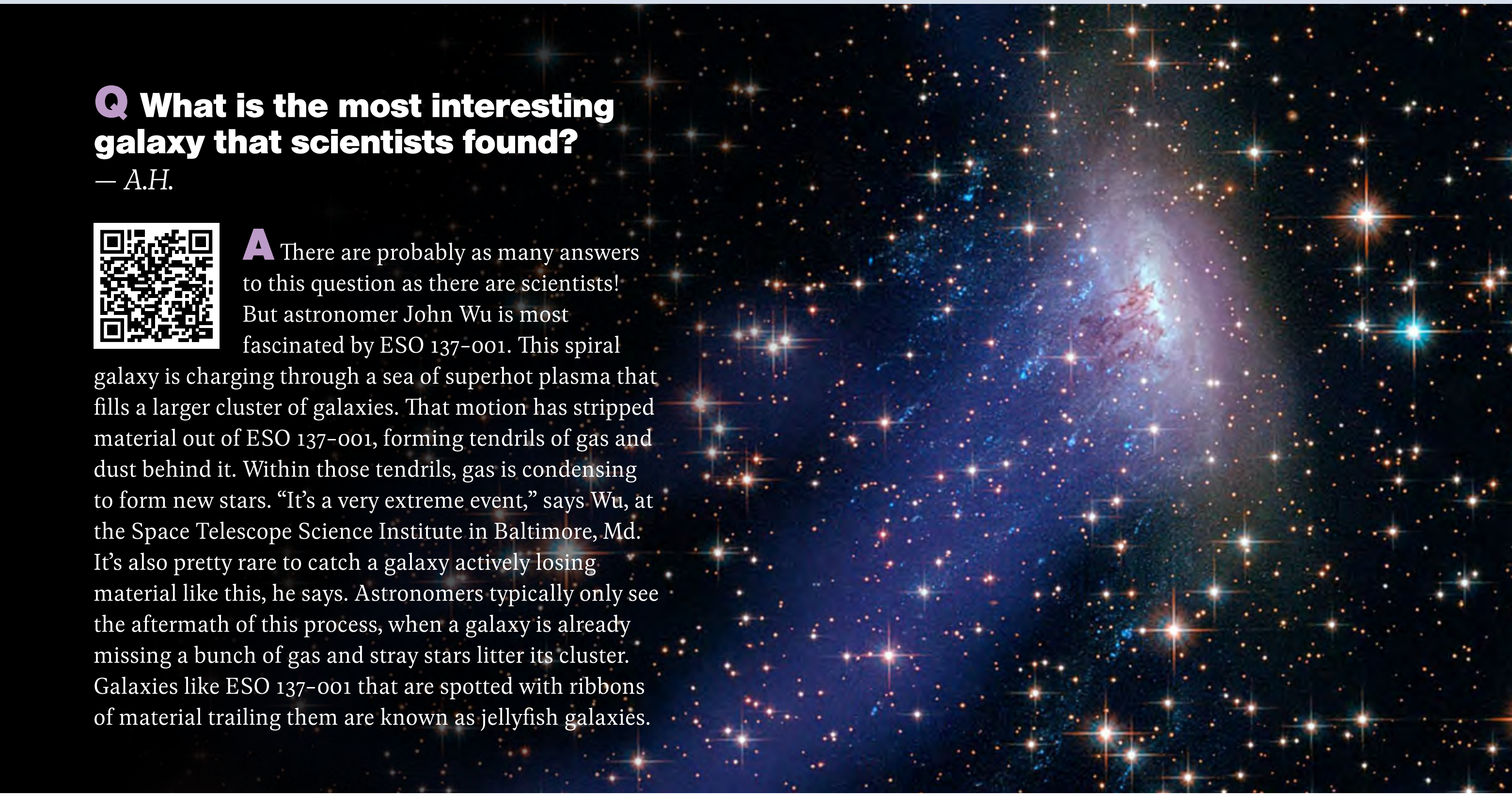


Q What is the most interesting galaxy that scientists found?

— A.H.

A There are probably as many answers to this question as there are scientists! But astronomer John Wu is most fascinated by ESO 137-001. This spiral galaxy is charging through a sea of superhot plasma that fills a larger cluster of galaxies. That motion has stripped material out of ESO 137-001, forming tendrils of gas and dust behind it. Within those tendrils, gas is condensing to form new stars. “It’s a very extreme event,” says Wu, at the Space Telescope Science Institute in Baltimore, Md. It’s also pretty rare to catch a galaxy actively losing material like this, he says. Astronomers typically only see the aftermath of this process, when a galaxy is already missing a bunch of gas and stray stars litter its cluster. Galaxies like ESO 137-001 that are spotted with ribbons of material trailing them are known as jellyfish galaxies.

NASA, ESA, AND THE HUBBLE HERITAGE TEAM (STSCI/AURA); ACKNOWLEDGMENT: M. SUN (UNIVERSITY OF ALABAMA, HUNTSVILLE)

Q What’s in helium that makes balloons float?

— C.D.

A The helium gas inside balloons consists of atoms of the element helium. It’s the second lightest element on the periodic table. The elements that make up the gas in our atmosphere — mainly nitrogen and oxygen — are heavier than helium. In physics, the law of buoyancy says that an object in a liquid or gas will experience an upward force. The strength of that upward force is equal to the weight of the liquid or gas that an object displaces. When a helium balloon gets inflated, it pushes aside the dense air surrounding it. The total weight of the balloon — rubber or foil, string and all — is less than the weight of the air it pushed aside. So, according to the law of buoyancy, the surrounding air pushes back on the helium balloon with a force equal to the displaced dense air. That creates a buoyant force greater than gravity that sends a helium-filled balloon soaring into the sky.

Q How does Bluetooth work?

— Selah L.

A Bluetooth uses radio waves to send signals between devices. That allows smartphones, earbuds, speakers and other tech to wirelessly connect. The radio waves used for Bluetooth signals have frequencies from about 2.402 to 2.48 gigahertz (GHz). (That is, their radio waves wiggle back and forth around 2.4 billion times per second!) Wi-Fi routers and cellphone towers rely on these same frequencies. But Bluetooth signals aren’t as strong. As a result, this technology only works over distances of up to 9 meters (30 feet). When devices link up through Bluetooth, they randomly tap into one of 79 available frequencies. Once connected, the devices hop between these frequencies to avoid interference from other wireless devices.

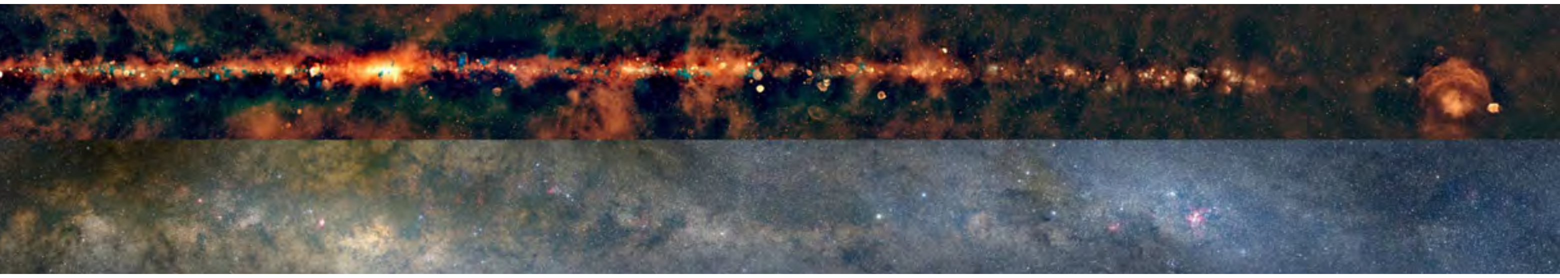
Do you have a science question you want answered?

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

SPACE

This is the largest, most detailed radio image yet of the Milky Way

It unveils greater details of what's happening within our galaxy



This radio-light view of the Milky Way (upper panel, above), looking toward its center, has been artificially colored to show lower-frequency waves in red and higher-frequency waves in blue. Its perspective appears far different from a view of the same region in visible light (lower panel, above). Inset (below) shows one section at higher magnification.

A ribbon of red splotches peppered with blue dots offers a new view of our Milky Way. It's the largest, most detailed image of our galaxy in radio wavelengths ever assembled. Researchers described what it shows in *Publications of the Astronomical Society of Australia*.

Taken from Earth's southern hemisphere, the image is a new side view of our fairly flat spiral galaxy. The image will help astronomers find and classify objects within the Milky Way.

The new image was prompted by a search for supernova remnants. These are leftover bubbles of gas and dust from exploding stars. These remnants can emit radio waves for tens of thousands of years, says Silvia Mantovanini. So most of these objects have been found when looking for radio light. An astronomer, Mantovanini worked on the new image while at Curtin University. That's in Perth, Australia.

Researchers have found about 300 supernova remnants in the Milky Way. Scientists estimate some 2,000 likely exist. However, it's been difficult in past studies to tell apart these remnants from other objects. Studying more stellar remains will shed light on the last stages of stars' life cycles and their explosive ends, says Mantovanini.

For the new image, researchers compiled radio wavelengths captured over more than 140 nights. These data were collected by the Murchison Widefield Array telescope in Western Australia. The telescope mapped the southern hemisphere's sky as part of two surveys between 2013 and 2020.

Each observation took a snapshot of one section of the sky. Each snapshot lasted about two minutes and captured a specific range of radio wavelengths. Supercomputers then stitched together almost 2,000 of these observations.

This revealed a dazzling edge-on view toward the center of the Milky Way. It spans roughly 60,000 light-years. That's just over half the galaxy's width.

The team then stacked 20 versions of the image. They gave each version a different color. Those colors denote various ranges of radio wavelengths. Longer ones appear red. Shorter wavelengths are shown as blue.

Those colors hint at what's behind the radio emissions. Heat-related radiation from stellar nurseries, for instance, look like blue bubbles. Emissions from supernova remnants that don't come from heat appear as red bubbles.

UPPER AND INSET: S. MANTOVANINI AND THE GLEAM-X TEAM; LOWER: AXEL MELLINGER/MILKYWAYSKY.COM

This colorful view of the Milky Way makes it easy to see what's going on within our galaxy, Mantovanini says. Its creation "reminded me that we're just a small part of something incredibly complex."

— MCKENZIE PRILLAMAN

EARTH

3.5 meters per second

The average peak velocity of the attack of a terciopelo (*Bothrops asper*) — a type of viper found in Central and South America

Source: S.G.C. *Cleuren* et al/J. of Experimental Biology, *2025*

MATERIALS

Why ammolite gems shimmer like rainbows

Delicate crystal structures give the fossils their flair

Ammolite gems get their rainbow shimmer from tiny gaps between their crystal plates. These fabulous fossils form from the shells of ammonites, prehistoric cousins of today's octopuses and squids.

Ammolites are some pretty fabulous fossils. Their vivid rainbow hues make them prized gemstones. But how ammolites' shimmery colors form has been a mystery — until now.

Ammolite comes from some fossilized shells of extinct mollusks called ammonites. Scientists knew the fossils' flair arose from their layers of nacre. (This is the same substance that pearls are made of.) So researchers in Japan examined the crystal plates that make up the nacre in pieces of ammolite. The gems came from the 75-million-year-old Bearpaw Formation in Alberta, Canada.

Ammolite pieces with thinner crystal plates reflected shorter wavelengths of light. That gave the gems deep blue hues. Pieces with thicker plates reflected longer wavelengths. These painted those pieces in rich reds.

The team also looked at the crystal plates in other ammonite fossils that did not boast brilliant colors. And they inspected shells from nautilus and abalone, which are living mollusks that contain nacre but lack ammolite's colors. That let them see how ammolite's structure differed from other, duller nacres.

In ammolite, crystal plates were separated by pockets of air about 4 nanometers wide. In abalone, 11-nanometer-thick gaps sat between its plates. And in a duller ammonite fossil from Madagascar, the plates had collapsed together, leaving no gaps.

Models revealed why 4-nanometer gaps were the sweet spot for bright, distinct colors. More tightly packed plates didn't reflect as much light. That dulled their color. More widely spaced plates reflected many different wavelengths, muddling it.

The layers across a single piece of ammolite also tended to have the same thickness, helping them reflect distinct colors of light. These results appeared in *Scientific Reports*.

— MARIA TEMMING

KEVIN VENEGAS BARRANTES/SHUTTERSTOCK; LORI EPSTEIN/ALAMY

HEALTH

A new safety device could help improve avalanche survival

To test it out, volunteers agreed to be buried in the snow

These avalanche rescuers took part in a 2025 training exercise at a ski resort in the French Alps. A field trial of a new safety device (not pictured here), which channels air to a buried person's face, suggests it may buy time for a rescue.

OLIVIER CHASSIGNOLE/AFP/GETTY IMAGES

When a person is trapped in an avalanche, there is very little time before their oxygen supply runs out. A new safety device, though, can channel air to the buried person's face. It may extend their survival time and increase the chance of a successful rescue, a clinical trial suggests.

In the trial, participants were buried face-down under 50 centimeters (1.6 feet) of snow at a field site in northern Italy. The goal was to remain there safely for 35 minutes. No one wearing the new safety device needed to be removed early due to low blood oxygen levels. Researchers reported this in the *Journal of the American Medical Association*.

Minutes after being buried in an avalanche, a person's blood levels of oxygen will begin to drop. At the same time, levels of carbon dioxide climb. The chance of survival decreases starting at 10 minutes. Around two-thirds of people whose upper bodies are trapped will die of insufficient oxygen within 35 minutes.

The new battery-powered device is integrated into a backpack and weighs a little over 500 grams (1.1 pounds). Called the Safeback SBX, it uses a fan to draw air from the surrounding snow. That air is then directed to the buried person's face from outlets in the backpack's shoulder straps.

In the trial, researchers monitored participants' health vitals, including heart and respiratory rates. The experiment ended if anyone's blood oxygen levels dipped below a dangerously low 80 percent. This did not happen for the 12 people in the safety device group. Eleven remained buried for the full 35 minutes. One asked to be removed early due to skin irritation.

In contrast, seven of the 12 people using a sham device had to stop early after their blood oxygen fell below the cutoff point. Most people in the sham device group remained buried between five to 13 minutes. Only one person in that group stayed buried for the full 35 minutes.

Avalanches kill an average of 100 people in Europe each year. In the United States, avalanche deaths have ranged from roughly one dozen to several dozen for the last several years.

—Aimee Cunningham

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

SLOW SCIENCE

These ultra-long experiments outlive their scientists — on purpose

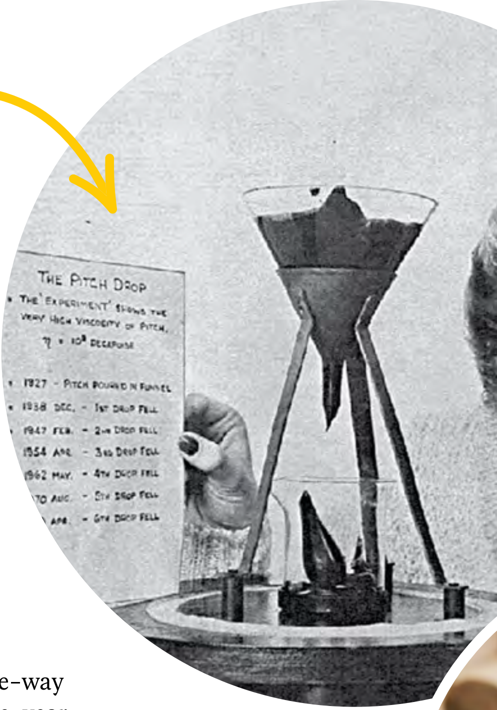
BY **STEPHEN ORNES**

On a snowy night in Michigan in 2021, five shivering scientists set down their shovels and studied a hand-drawn map by flashlight. The map led to a secret location. If they dug in the right place, they would find bottles made of thick glass. They'd been buried side-by-side almost 150 years earlier.

This was no ordinary hidden treasure. It was a science experiment.

DERRICK L. TURNER, MICHIGAN STATE UNIVERSITY

As part of an experiment that began in 1879, scientists from Michigan State University dug up bottles of seeds in 2021 from a secret location.


This picture was taken in 1979, after the sixth pitch drop. Since then, three more drops have fallen, the last in 2014. No one has ever seen one fall.

In the fall of 1879, botanist William James Beal filled 20 pint-sized bottles with seeds and sand. Every bottle held 50 seeds each from 23 types of weeds. Beal reported he had buried the bottles on a "sandy knoll" near the Michigan State University campus in East Lansing. He drew a map of this stash so he could unearth a bottle every five years.

He wanted to answer a simple question: How long can stored seeds still sprout? Seeds are alive but dormant. You can plant last year's tomato seeds to get a new bounty this year. But is there a cutoff? Do those dormant seeds eventually die or go bad?

That's not a question you can answer quickly. The buried seeds offer some useful clues. "Turns out," says David Lowry, those seeds can remain viable for "a long time." Weed seeds, he says, can outlive the farmers who want them gone. "Some last decades, if not over a century."

A plant biologist at Michigan State University, Lowry was there on that snowy night in 2021, wondering if they'd ever find Beal's bottle. He's among the latest in a long line of scientists who know where the bottles are buried. He's also the current keeper of Beal's map.

The lifespan of seeds isn't the only thing that takes a lot of time and patience to measure. And the Beal seed inspectors aren't the only scientists in it for the long haul. Long-term experiments have yielded surprising discoveries in biology, ecology, physics and space.

"The time on Earth that you have is sort of just one small slice of time," says Jennifer Powers. She's an ecologist at the University of Minnesota in St. Paul. Spreading such projects over human lifetimes, she says, can illuminate patterns in nature that we might otherwise miss.

THE LONG AND SHORT OF IT

Some super-long scientific endeavors begin as short-term projects. Designed to last only a few years, they might just keep going.

In 1977, for example, NASA launched its Voyager mission. The agency sent two spacecraft on a one-way trip into space. The twin probes' five-year mission was to visit Jupiter and Saturn.

The spacecraft did their job spectacularly. Each sent back detailed images of the rings of Saturn. Images of Jupiter showed the first lightning ever seen beyond Earth. The probes also confirmed the existence of volcanoes on Jupiter's moon Io. For the first time, scientists could study moons beyond our own.

"These tiny pinpoints of light became worlds in their own right," says Linda Spilker. A planetary scientist who still works on Voyager, she's based at NASA's Jet Propulsion Laboratory. That's in Pasadena, Calif.

Plant biologist Frank Telewski (left) was long in charge of the map showing where Beal's seeds were buried in 1879. In 2021, he and his team removed a bottle (far left) from the ground and planted the seeds. Several sprouted (inset above).

DERRICK L. TURNER

When struck with a hammer, fluid pitch shatters like a solid.

But the Voyager spacecraft didn't stop working after they sailed past Saturn. The probes are still beaming important data back to Earth. In 2012, Voyager 1 exited the heliosphere. Voyager 2 did the same in 2018. Today, they're scouting out interstellar space.

Recalls Spilker, "No one imagined [in the late '70s] that Voyager … would still be flying" almost 50 years later.

Other experiments are built to last. The Guinness World Record for the longest-running lab experiment is held by a peculiar project still going at the University of Queensland, in Australia.

It was started in 1927 by Thomas Parnell, the university's first physics professor. He filled a funnel with pitch — the sticky black stuff used to pave roads. Pitch seems solid. It can be shattered with a hammer. But pitch is, in fact, a thick fluid. Parnell wanted to know how often his glop of pitch would drip.

To find out, he let the pitch cool for three years. Then he cut the funnel open in 1930 and began counting the drips.

Over nearly a century, just nine drops have fallen. To date, no one has ever seen it happen in person. The most recent drop fell in 2014. Scientists predict the next will fall within a few years.

Parnell originally set up the demonstration to teach his students about the high viscosity, or thickness, of pitch. Now, scientists point to it as an example of a natural phenomenon that happens very slowly.

ONLY TIME WILL TELL

For other extremely long-term experiments, Mother Nature is the lab. Take a mountain forest in Oregon where ecologists are studying log decay. Designed to last 200 years, this experiment kicked off in 1985. That's when ecologists arranged more than 500 newly cut logs throughout the forest.

Forests are rich with dead wood. This wood provides homes to animals and stores nutrients such as carbon and nitrogen. Fungi and other breakdown artists eat through tough wood and repurpose its nutrients. Rotting wood recycles carbon into the air, which plays a role in Earth's climate.

While some logs break down quickly, others decay over decades or centuries. So ecologists still have much to learn about how ecosystems go about recycling their dead. This ultra-long experiment on log decomposition could help.

"We know we'll have to go for at least a century or two to figure out what's going on," says Mark Harmon.

The pitch drop experiment (above) holds the record for the longest-running lab experiment. In 1927, a physicist in Australia wanted to see how often pitch — the sticky stuff used to pave roads — would form droplets. Since then, only nine drops have fallen.

THE UNIVERSITY OF QUEENSLAND

A forest ecologist at Oregon State University in Corvallis, he organized the experiment and ran it until he retired a few years ago.

Harmon knows he won't see what patterns emerge after 200 years. When the experiment launched, he had to have some confidence that it would continue even after he left. "Why couldn't I have faith?" he says.

Early data showed his team that decay rates vary dramatically among species and in different climates. One type of wood in the tropics may vanish in as little as a year. Others in drier areas may remain on the ground for centuries.

There are now dozens of other log-decay projects around the world. Powers at the University of Minnesota runs one in Costa Rica. There are also sites in Alaska, China, Germany and the Netherlands.

WHAT'S NORMAL — AND WHAT'S NOT

Many long-term projects focus on ecosystems — places where living things interact with each other and with their surroundings. A forest ecosystem includes trees, soils and creatures big and small. Some changes happen quickly, as when a tree falls or wildfire rips through. But others, like tree growth and decay, can take decades or centuries.

"Trees are very long-lived," says Pamela Templer, a biologist at Boston University in Massachusetts. If an ecologist goes into a forest and makes one measurement, they may not know if that data point was unusual or not. "It's hard to say," she says. "Was it extreme, or in line with the long-term record?"

Recording data over years or decades or centuries can establish what's called a baseline. That's what an ecosystem looks like most of the time. Scientists can then compare new measurements to that baseline to see if they're unusual.

Templer studies how human impacts such as climate change affect the health and growth of forests. Trees hold 80 percent of all the carbon stored above ground on Earth. But climate change may affect the way trees store and release carbon — which may, in turn, drive climate change. Understanding that feedback loop can help scientists better predict Earth's future.

To investigate this, Templer does experiments at forests around the northeastern United States. One of those sites is the Hubbard Brook Experimental Forest in the mountains of northern New Hampshire. Since the 1960s, scientists have collected data there to learn how the forest changes over long periods of time.

In 2012, her team started an experiment to simulate climate change across seasons. They heated the soil in a test plot of land using underground wires. The scientists also created a test plot where, every winter, they removed snow.

The team shared its first results last year. Warmer temperatures boosted tree growth, they observed. Over about a decade, trees on the warmed plot stored about 60 percent more carbon than other trees. "That was shocking to us," Templer says. Trees may adapt to climate change by growing faster and holding on to more carbon, keeping it out of the atmosphere.

But without snow, tree roots and soil were damaged by freezing winter temperatures. That cut warmed trees' extra carbon storage by half. So the combination of warmer temperatures and less snow led to a 30 percent overall increase in carbon storage. "It's still a net benefit," Templer says. "That could reduce carbon dioxide concentrations in the atmosphere." It suggests a new way that trees could help slow climate change. And without an experiment that ran for over a decade, scientists never would have found it.

A LASTING LEGACY

When a scientist sets up a study that will last longer than their own lifetime, they have to trust that someone else will keep it going. That can be a risk. "The problem with long-term experiments is that someone may set them up, but if there's no follow through, then it can't continue," says Lowry, in Michigan.

While he was working on the Beal Seed Experiment, Lowry heard rumors of another, older seed experiment that had been started at Ohio University in

Sometimes scientists need years, decades or even longer to observe certain things. For instance, a soil-warming experiment in New Hampshire (right) took about a decade. The Voyager spacecraft (inset below) have been traveling for more than 45 years. And a tree decay experiment (below) could last centuries if maintained.

Scientists artificially heated the soil in this patch of New Hampshire forest to understand how snowpack and climate change are affecting tree growth.

Deep in a mountain forest in Oregon, ecologists study logs as they decay. Ecologist Mark Harmon (inset) ran the study until he retired and still actively works on it.

S. ORNES; P. TEMPLER (CC BY-SA 4.0); NASA/JPL-CALTECH; HACHETTE BOOK GROUP

Athens. “It’s reported to be done, but there’s no record of it afterwards,” he says. Any discoveries scientists may have made are lost.

But the Beal Seed Experiment has continued. Beal left the experiment in 1915 and asked another scientist to take over.

By 1920, the seeds were still sprouting, so Beal’s successor switched things up. Instead of digging up a bottle every five years, they did it every 10 years. In 1980, scientists extended the time between bottles to 20 years. Most of the seeds stopped sprouting in the first six decades of being buried. But some continued to sprout, time after time.

Lowry didn’t join the project until around 2016. At the time, plant biologist Frank Telewski was the eighth, and sole, keeper of the map. After one of his colleagues died unexpectedly, he wanted to make sure the project would continue if something happened to him.

“He told me, ‘Here’s the map in case I have a heart attack or something.’ He was joking around,” Lowry says. “And then the next month he had a stroke.”

Telewski recovered, but it was a wake-up call. “More people than just one person should have the map,” Lowry says. Now, four people have access to the map.

On that snowy night in 2021, Lowry and his team finally found the cache of buried bottles. They brought one bottle — the 16th — to the lab and planted its seeds. “When the first [sprout] came up, I was the first one to see it,” Lowry says. “There it was. That was extremely exciting.”

Ultimately, 20 seeds sprouted. All of them were *Verbascum*, a flowering weed with hairy leaves that flourishes on the edge of ditches and meadows. Lowry and his colleagues confirmed their identity using genetic tools that weren’t available last time a bottle was studied. The next bottle won’t be examined until 2040.

Scientists want to make contributions to their fields and be known for their work. “But at a certain point you’re no longer there,” Lowry says. “The science continues without you. And it’s important to recognize that it’s a process that’s bigger than individual humans themselves.” ◗

READ MORE

The Forest Revealed

By Jada Fitch & Kateri Kosek

The long lives of trees make them perfect for decades-long research projects. Learn more about what the forest endures month-by-month with this illustrated guide.

Pitch Perfect


HARRY HOW/STAFF/GETTY IMAGES SPORT

Want to be a great pitcher? Apply a little physics

BY **WENDY ORLANDO**

SHOHEI **OHTANI**

PITCHER

LA DODGERS

Pitching a ball isn't as simple as throwing it toward the batter, no matter how easy professionals — such as Shohei Ohtani of the Los Angeles Dodgers — may make it look. The ball needs to be held and released in certain ways. It must fly at a certain speed. Sometimes a pitcher will want a ball to curve in a particular direction. Other times, no curve is best.

Understanding why pitches curve — or don't — can help you send the ball on a trajectory of your choosing. After all, the reason a pitched ball takes the path it does is not magic. It's science.

Every thrown ball will eventually fall downward, due to gravity. We expect this. And we expect the ball to fly toward the spot where the pitcher aimed it. What we don't expect are additional motions: a shift in a ball's path that goes further left, right, up or down from where the pitcher aimed it — and from what gravity would have caused. Such changes to the expected flight path are called movement or curve.

Let's look at the science behind why a pitched ball takes the path it does. Along the way, we'll learn how the pros in baseball, fast-pitch softball and cricket grip and release the ball to bend its path to their will.

THE ROLE OF SPIN

The most common thing that makes a ball curve is its spin.

Consider a baseball flying through the air to the left. As it soars, the ball is spinning counterclockwise. This is known as having topspin: The top of the ball spins down in the direction of the ball's flight.

As the ball travels leftward, air flows around it toward the right. Some of that air flows under the ball. This air hugs the spinning ball and gets pushed upward around the back of the ball. Other air flows over the ball. This second batch of air collides with the first batch rising up behind the ball — and creates a mess above the ball.

The air flowing above, below and around the sides of a ball all contribute to a "wake" — a complicated flow of air that trails the ball. For a topspinning ball, the wake is shifted up, above the ball's center.

Isaac Newton's Third Law states that when one object exerts a force on another, that second object will push back, exerting an equal and opposite force on the first object. Based on this law, if a ball pushes the wake of air upward, the wake must push the ball downward.

That push on the ball is called the Magnus effect (which creates the force known as lift). For a ball with topspin, the Magnus effect pushes downward, so the ball heads down. Note that the ball moves in the same direction as the leading edge is spinning, and the wake moves in the opposite direction.

But not every ball has topspin. The Magnus effect can make pitches bend in other directions, too.

Let's see how the Magnus effect explains certain types of pitches. (You may want to get your hands on a ball and glove for this part.)

HOW BALLS CURVE DUE TO MAGNUS

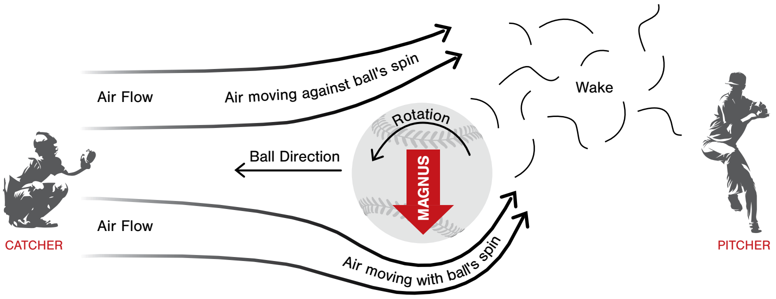
In baseball, pitchers throw curveballs with mostly topspin. You now know why those pitches mostly curve downward.

Gravity alone makes baseball pitches descend about 1 meter (more than 3 feet) as they travel from the pitcher's mound to home plate. Curveballs can drop another 30 centimeters (1 foot) or more due to the Magnus effect.

A fastball in baseball, on the other hand, has backspin. The top of the ball spins backward, in the opposite direction to the ball's flight. In this case, a ball moving to the left would spin clockwise as it flies. To throw one, use your first two fingers to push down on the ball as you release it. This has the opposite effect to the topspin in a curveball.

THE MAGNUS EFFECT

The Magnus effect (illustrated here, not to scale) depends on how air flows over and under a ball. This baseball (viewed from the side) is spinning counterclockwise as it flies to the left, so it has top spin. Air moves with the spin under the ball and against the spin above. This pushes the wake of air behind the ball upward. That, in turn, pushes the ball down.



W. ORLANDO; MICHAL SANCA/SHUTTERSTOCK

NiJaree Canady is a star pitcher for the Texas Tech Red Raiders. In the 2025 season, she had 319 strikeouts and a 1.11 earned run average, or ERA. ERA is the average number of runs scored against a pitcher in nine innings, and the lower the better.

The ball's wake shifts downward and the ball is pushed upward.

This upward Magnus effect causes fastballs to drop less than they would due to gravity alone. They still drop, but it's hard to detect. So fastballs actually have hidden curve.

Spin and the Magnus effect also give curveballs their curve in fast-pitch softball — but toward the left or right instead of down.

Unlike the overhand throws used in baseball, fast-pitch softball pitchers hurl the ball underhand. To make it curve, they add sidespin to the ball. That means they rotate the ball around its vertical axis (like the Earth does once per day).

LET IT GO

Marcus Orlando demonstrates common grips — for a righty pitcher — used for different pitches in different sports. (There are many other options, too.) What is most important is the release: what to do as you let go of the ball.

Curveball

BASEBALL

GRIP DESCRIPTION

- Form a reverse "C" with your first finger and thumb
- Place your middle finger just inside the seam

RELEASE

- Twist your hand away from you
- Turn over the "C"
- Pull down with your middle finger

4S Fastball

BASEBALL

GRIP DESCRIPTION

- Place your first two fingers cross the two seams
- Place your thumb under the ball

RELEASE

- Push down with the first two fingers
- Throw as hard as you can

Knuckleball

BASEBALL

GRIP DESCRIPTION

- Dig the nails of your first two fingers into the seam
- Hold the ball back in your palm

RELEASE

- Push the ball out with your fingers and thumb
- Try to give the ball no spin

Curveball

FAST-PITCH SOFTBALL

GRIP DESCRIPTION

- Place your hand under the ball
- The first two fingers each sit on the outside of a seam
- Use the narrowest part of the seams

RELEASE

- After windup, with the ball at your outside hip, rotate your hand counterclockwise from above
- Rotate your hand toward the other hip as you release

Screwball

FAST-PITCH SOFTBALL

GRIP DESCRIPTION

- Use the same grip as for a curveball but with your hand on top of the ball

RELEASE

- Rotate your hand clockwise
- Push hard with your first finger on the seam
- Lead with your pinky finger

Outswinger

CRICKET

GRIP DESCRIPTION

- Place your first two fingers along the seams
- Hold the ball with the seams straight up and down and angled away from the batsman

RELEASE

- Use an overhand release with your arm fully extended
- Keep your wrist pointed away from the batsman

TYLER MCFARLAND/CONTRIBUTOR/NCAA PHOTOS; W. ORLANDO

After just two years in Major League Baseball, Paul Skenes has the lowest ERA (1.99) for his first 46 games of any starting pitcher in 105 years.

JUSTIN K. ALLER/STRINGER/GETTY IMAGES SPORT

A right-handed softball pitcher will spin the ball to the left for a curveball. (That's counterclockwise seen from above.) The ball's spin pushes its wake to the right. The wake, in turn, pushes the ball to the left. For a righty softball pitcher against a righty batter, a curveball will break, or curve, away from the batter. (A left-handed pitcher will spin the ball to the right, and it will break to the right. That's toward a righty batter or away from a lefty batter.)

Another pitch some pitchers have is a screwball. In fast-pitch softball, the delivery and path of a screwball are the mirror image of a curveball. The pitcher spins the ball in the opposite direction, and the ball moves the other way. Thus, a righty pitcher's screwball will spin clockwise (seen from above) and curve into a righty batter. Few pitchers can throw this pitch, by the way, so it's a good one to try. Maybe you can do it!

Magnus has explained a lot so far. But for other types of tricky pitches, we need more physics.

SEAMS AND SEPARATION

As devices go, baseballs and softballs seem simple. Once they're put into play, however, a lot can happen.

"This is the most fascinating object ever made by humans," says Bart Smith, holding up a baseball. Smith is a mechanical and aerospace engineer at Utah State University in Logan. He studies the aerodynamics of baseballs. That is, how they fly through the air.

As a ball flies, very thin "boundary layers" of air form right next to the ball. They are so thin that we can't see them just with our eyes. But the ball's movement hinges on how these layers behave.

A ball's boundary layer is like a preschooler trying to walk on a curb: It can only stay on for so long before falling off. A boundary layer eventually will pull away or separate from a moving ball's surface on its own. This will then change the wake behind the ball.

However, there are ways a pitcher can trigger an early separation, changing a ball's trajectory from the path it would normally take. One secret to making a boundary layer peel away is by using a ball's seams.

To make a baseball or softball, manufacturers sew two pieces of leather together to cover the surface. Each piece is shaped like a dog bone. The stitches on those curvy dog-bone shapes loop around a ball in a complicated pattern. This shape "caught on because it was a pretty economical way to do it," says Smith, meaning it didn't cost much money.

When a ball's seam is at the right spot, it can prompt a boundary layer to separate. But this only matters for certain pitches.

Most pitches have lots of spin. This can cause a lot of seam effects to cancel each other out, notes Alan Nathan, a physicist at the University of Illinois Urbana–Champaign. Many fast-spinning balls don't show a big effect from seams.

Pitches with little to no spin, called knuckleballs, are another story.

A good knuckleball rotates just once or twice between the pitcher and catcher. That sounds simple, but the result is not. The slow rotation gives the ball time to react to a seam that has rotated into the airflow. A seam could interfere with a ball's boundary layers enough to change its trajectory.

Scientists, including Smith's team and Nathan, have been gradually piecing together how the seam affects a ball's flight path.

In the right position, a seam could trigger a boundary layer to separate early. If this happens on only one side of the ball, the wake of air behind it shifts. This would cause the ball to shift as well — in the direction opposite that of the wake.

The outer cover of a baseball (center) is formed by two dog bone–shaped pieces of leather sewn together with a complicated seam pattern. A softball (left) is larger and softer but has the same seam pattern. A cricket ball (right) is similar in size to a baseball, though heavier, and has seams that run in straight lines around its middle.

A few tenths of a second later, the seam on a knuckleball might find itself in another position relative to the air's flow. This could affect a different boundary layer, changing the ball's movement again. All of this could happen in the less than one second that a ball takes to reach the batter!

Note that this movement cannot be explained by the Magnus effect.

A warning from Nathan: Don't throw a knuckleball if you can't do it with just a little spin. "The great danger of any knuckleball pitcher is you accidentally put too much spin on," he says. Then it won't have these odd movements — movements that defy a batter's ability to connect with the ball.

'BOWLING' OUTSWINGERS AND INSWINGERS

Cricket offers yet another ball movement that cannot be explained by the Magnus effect. In this sport, players who pitch the ball are called bowlers. They, too, apply spin — but differently than in baseball and softball.

Unlike the curved seam on a baseball or softball, the stitches on a cricket ball run in parallel lines along its equator. Bowlers learn to spin the ball along this seam. Like a spiral in football, that spin stabilizes the ball. In cricket, the spin keeps the seam in the same place throughout the ball's flight.

Bowlers release the ball with the seam straight up and down. However, they can angle the seam slightly away from the batter, known as the batsman. This makes airflow on one side of the ball different from that on the other.

Consider typical bowled speeds of around 30 meters per second (70 miles per hour). On the side without the seam in front, the boundary layer of air at those speeds is laminar — meaning smooth. On the other side, the seam "trips" the boundary layer of air, making it turbulent — with energetic motion in many directions.

This turbulent air layer has more energy than the laminar one. That lets it hug the ball longer, partly around the back of the ball. This pushes the wake toward the laminar side. Thus the ball swings the other way — toward the seam side and away from the batter.

This curved trajectory is called an "outswinger." Alternatively, the bowler can angle the seam toward the batsman. This will swing the ball toward the batsman, producing an "inswinger" curve.

Again, this is not due to the Magnus effect.

THIS IS JUST THE BEGINNING

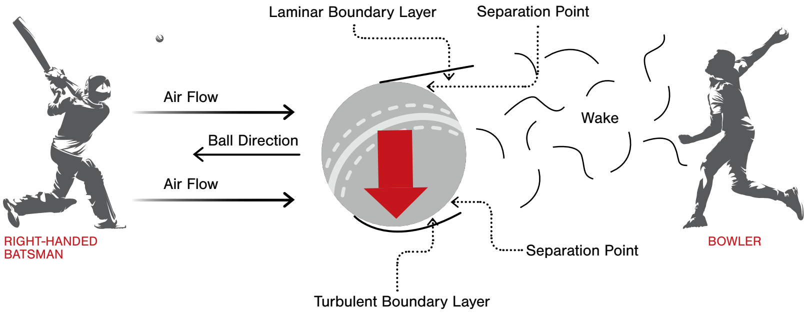
Plenty of other pitches can also impart a curve to a ball — or not. There are sliders, sweepers and change-ups. There are the effects of gyro-spin in baseball, which is spin in the same sense as the spiral of a well-thrown football. There are even cases in which certain balls move in the opposite direction to that which the Magnus effect would predict.

But there's one key element to all pitching. "It takes a lot of time and effort to learn how to do it," says Emily Richardson, who was a softball pitcher in college. She now teaches biology and coaches fast-pitch in the Chicago Public Schools in Illinois. So the number one rule to making pitches do what you want them to, she says, is practice: "It's throwing lots of pitches."

So go on, get out there and start pitching!

OUTSWINGER

This diagram (not to scale) shows an "outswinger" pitch in cricket. The ball is viewed from above. The ball's seam is angled away from the batsman (in this case, a right-handed batsman). A laminar boundary layer forms on the batsman's side of the ball, which has no seam. On the other side, the ball's seam trips the boundary layer into turbulence. The laminar boundary layer separates from the ball earlier than the turbulent one does. This causes the wake to shift toward the batsman's side and the ball away from the batsman's side (but this is not due to Magnus).



STEVE CUKROV, FORDHAM DABNEY, SANIT FUANGNAKHON/SHUTTERSTOCK; W. ORLANDO; MICHAL SANCA/SHUTTERSTOCK

This biomechanist uses physics to help athletes avoid injuries

Jessica Talmage identifies problems in the ways athletes move

Jessica Talmage played sports for as long as she can remember. She recalls smacking baseballs off tees at age 4. And she loved being on a team. Then, she hurt her shoulder playing high school softball. “It’s really hard to walk away from [sports],” she says. “Especially when growing up, I feel like playing sports was all I did.”

To help heal her hurt shoulder, Talmage visited a physical therapist. That’s a health expert who uses specific exercises to strengthen muscles and improve movement after an injury. She liked learning how to slowly strengthen her shoulder. When it came time to apply to college, she took a swing at studying sports medicine.

Today, Talmage is a biomechanist. This type of scientist uses physics to understand how the body moves. Talmage directs a biomechanics lab at Northern State University in Aberdeen, S.D. She works with athletes to see how different forces impact athletic movements, such as pitching a baseball. She also collects data on players and collaborates with sports medicine professionals to help athletes avoid injuries and improve their performance. In this interview, she shares her experiences and advice with *Science News Explores*. (This interview has been edited for content and readability.) — *Carly Kay*

Q How did you get to where you are today?

A It wasn’t until my sophomore year in college that I heard about biomechanics. I learned that biomechanists interact with physical therapists, athletic trainers, team doctors, strength and conditioning coaches, team coaches and athletes. That’s what was really enticing about the field. I didn’t have to pick one career direction and could combine my interests.

Q What does your work as a biomechanist look like?

A We work with teams and individual athletes. For example, we had the baseball team come in for testing. In the biomechanics lab, athletes can do jumps, throwing and hitting. We also have these machines that measure things like hip and shoulder range of motion, quadriceps and hamstring strength, shoulder rotation strength and grip strength. And then we take all that information and use prior research to help us identify areas where the athlete could improve. These things are usually hard to see with the naked eye.

It’s really exciting as a biomechanist to identify something and help an athlete figure out what’s going on with them. There’s all these different reasons for why an athlete might be experiencing an issue. So, it’s fun to collaborate with everyone and brainstorm ideas as to what might be causing the problem.

Q What have you found challenging about your career?

A Biomechanics is tough. There’s a lot of math and science that goes into it. And so I think that in the field of sports science in general, it’s a challenge content wise. You need to understand physics and how to apply it to the body. And then you tie in anatomy and physiology, both of which are two very complex fields on their own.

Q What piece of advice do you wish you’d been given when you were younger?

A Keep your options open because you don’t know what’s going to get placed in your path. Not to be cliche, but it all works out. And know that it’s OK to ask for help. Lean on your teachers and outside resources.

J. TALMAGE

As a biomechanist, Jessica Talmage uses physics to better understand how bodies move. At Northern State University in Aberdeen, S.D., she collects data on athletes to help them avoid injuries and improve their performance. Much of her work focuses on baseball and softball players.

EARTH

Exploring our seasons

Thank Earth's tilt for spring, summer, fall and winter

By Science Buddies

Earth's tilted axis is the reason for the seasons. At one point in Earth's orbit around the sun, its northern hemisphere is tilted away from the sun while the south more directly faces our star. This is northern winter and southern summer. When Earth is on the other side of its orbit six months later, the opposite is true. In this experiment, we measure the temperature on a globe warmed by a heat lamp to see how it varies with latitude and relative positions of the globe and lamp.

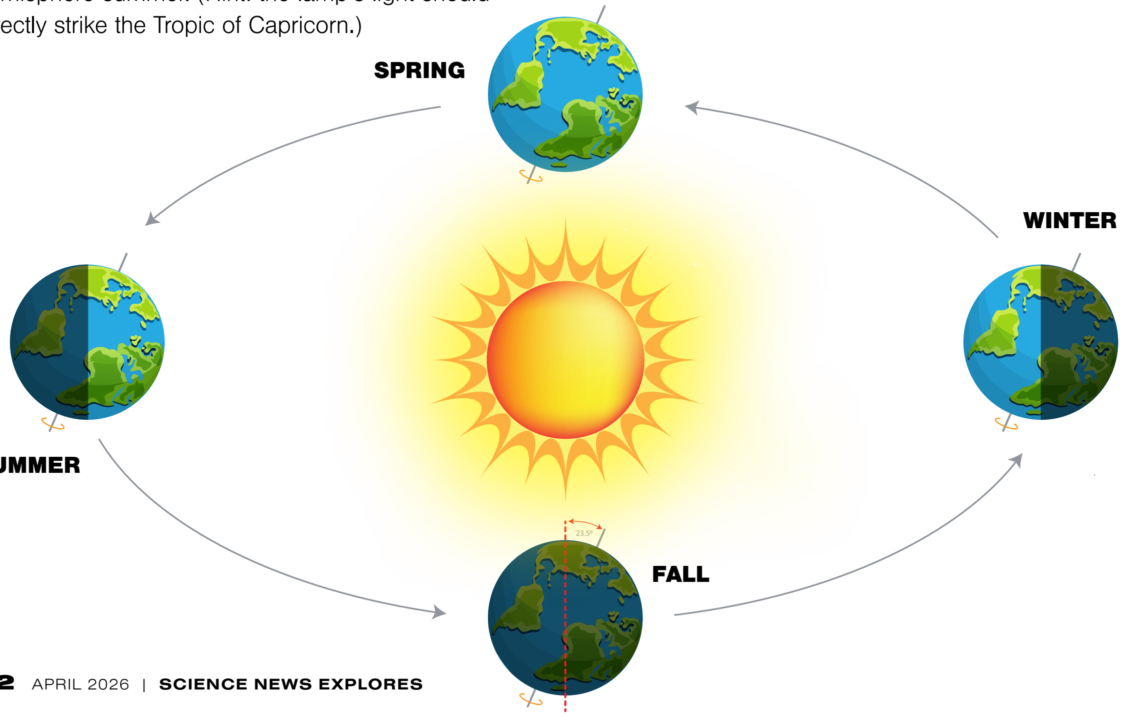
OBJECTIVE

Investigate how the tilt of Earth's axis determines the seasons

EXPERIMENTAL PROCEDURE

1. Place a heat lamp and a globe on a table.
2. Point the lamp horizontally toward the globe to gently and evenly warm it.
3. Position the globe as if Earth is in the southern hemisphere summer. (Hint: the lamp's light should directly strike the Tropic of Capricorn.)
4. Wait about five minutes.
5. Use an infrared thermometer to measure the globe's temperature at least three times at each of the following latitudes along the same longitudinal line: South Pole, Tropic of Capricorn, equator, Tropic of Cancer, North Pole.
6. Average your measurements for each latitude and write the data in a notebook.
7. Subtract the North Pole temperature from all other measurements. (Because the North Pole should not have received any light, this will give you the temperature change at every other location due to the heat lamp.)
8. Create a graph of temperature change versus latitude.
9. Repeat Steps 1–8 for all other seasons.

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



As the Earth orbits the sun, our planet's tilt shifts which hemisphere gets more direct sunlight. We experience these changes as seasons, shown here for the northern hemisphere.

PAPIA MAJUMDER/SHUTTERSTOCK

A Flamingo's Spin on Dinner

Written by Sofia Caetano Avritzer
Illustrated by JoAnna Wendel

On a trip to the zoo, Víctor Ortega Jiménez noticed the flamingos doing something bizarre. While sticking their beaks underwater, the birds were bobbing their heads and stomping their feet.

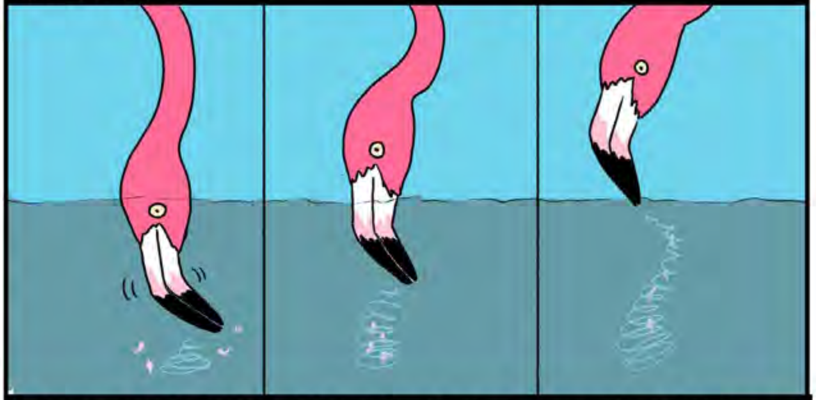
As an animal researcher at the University of California, Berkeley, he was immediately intrigued. Wild Chilean flamingos live in super salty lakes in places like the Atacama Desert.

Those waters swarm with brine shrimp — flamingos' favorite snack.

Ortega Jiménez wondered if the fancy footwork and head movements helped flamingos hunt for shrimp. So he reached out to the Nashville Zoo in Tennessee. Zoo trainer Jake Belair agreed to help.

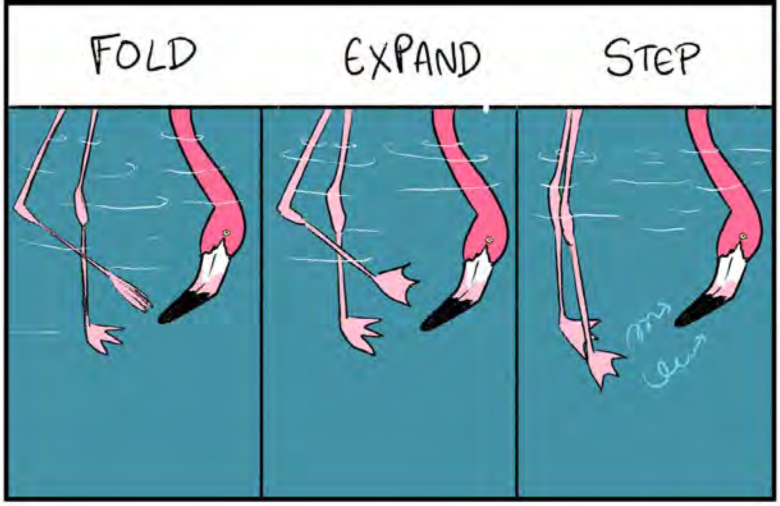
Belair set up a small plexiglass feeding trough for flamingos with a camera attached to one side. But it took six months to convince flamingos to eat frozen shrimp from it.

Turns out, flamingos' head-bobbing move created underwater vortices that sucked shrimp straight into their beaks. The birds also snapped their beaks 12 times a second.

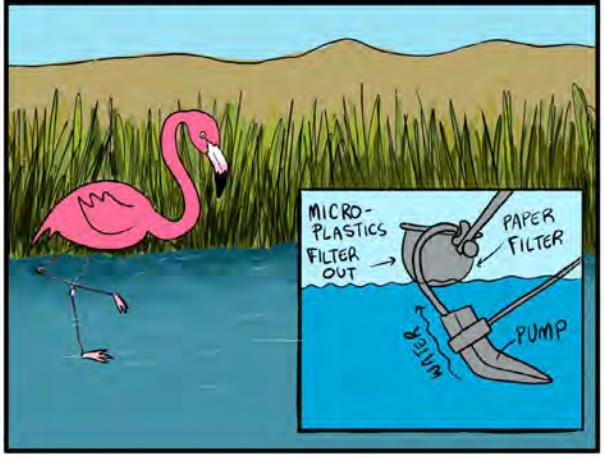


This move, called "chattering," helped the flamingo suck up water and shrimp.

Foot-stomping also played a role in the shrimp buffet ballet. Every time the flamingos took a step, they created little spirals of water that pushed shrimp up toward their mouths.



Flamingos make such good underwater vacuums, their "chattering" could inspire new filters to remove microplastics from rivers and oceans. So these animals' unique choreography could someday help keep their fishing grounds clean.

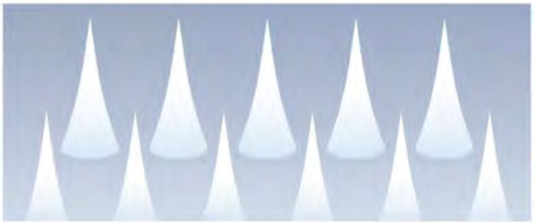


HEALTH

Bulb-shaped barbs help these pimple patches get a grip

The dissolvable anchoring tech could lead to future shot-free vaccines

Microneedles with bulb-shaped bases



Conventional microneedles

That pimple patch you're using now is so last year. A new type locks on to pesky pimples better. It also more effectively delivers zit-fighting ingredients. Its secret is its tiny, uniquely shaped needles.

Even if you hate needles, the ones in the new patches shouldn't spook you. They're "very short," notes Shayan Fakhraei Lahiji — 450 micrometers or less. That's less than two one-hundredths of an inch long. A bioengineer, Lahiji works at Cursus Bio. It's a drug company in Seoul, South Korea. He helped shape — literally — this new approach to acne treatment.

Each small, needle-packed patch is "almost invisible," he says. Once placed on a pimple, its needles lock in. The tiny pricks dissolve and disappear within two hours. After that, you can remove the transparent patch, he says.

Hyaluronic acid — a chemical that plumps up our skin — gives structural support to the microneedles. Those tiny needles then deliver antibacterial compounds right where they're needed. Inflammation-fighting chemicals also cool redness and swelling.

Among tests in treated people, 81 percent of patched pimples disappeared within three days. That's compared to 41 percent of non-treated pimples. Details of how the new tech works were published in *Biological and Medical Applications of Materials and Interfaces.*

Lahiji's team didn't invent pimple patches. People can buy simpler styles today. Many of those, too, use microneedles. But needles in the new patches have a unique geometry that anchors them in place. It sets them apart from what you can buy now, Lahiji says.

The microneedles used in other patches tend to be cone-shaped. But that means they easily slip out of the skin. The Korean team gave their needles a bulb-shaped bottom. They call the design "MicroLock." Like barbs, the needles lock in place.

The value of this shape-up could expand beyond the acne market, Lahiji says.

Slipping out of skin is a known problem with microneedle technology, says Ayhan Çelik. A chemical biologist, he works at Imperial Bioscience Limited. That's a drug technology company in Brighton, England. Çelik didn't work on the new study. But he, too, has been working on microneedle patches using hyaluronic acid.

Such patches show a lot of potential, Çelik says. For instance, they might one day provide shot-free options for the delivery of some injectable drugs. Or even vaccines.

A shot puts a lot of the medicine into a tiny area. In contrast, Çelik notes, patches would deliver a drug to a broader area — "not a single point." He believes that will lead to a better immune response than a typical shot.

STEVE MCCRACKEN

The needles of the new acne patch are too short to deliver a vaccine. But Lahiji and his team have developed other versions that might enable other uses for "locking" microneedles.

For now, notes Lahiji, there are no microneedle products for medicines that require prescriptions. But his team is working on ways that microneedles could deliver such drugs. One type would deliver medicines targeted at diabetes and obesity. His group described it in 2024 in *Advanced Materials.*

Governments regulate what new medical products can be used in their countries. These rules ensure those products are safe. Right now, no such rules exist for microneedle patches, Çelik notes. That makes them a headache for companies to develop and bring to pharmacies. "Everyone is waiting for" those guidelines, he says.

Acne patches are an exception to that. These patches are deemed cosmetic, not medical. Their needles not only are extra tiny, but they also deliver no prescription drugs — just over-the-counter acne-clearing meds.

Some issues remain with using locking microneedles for patch delivery of other medications. Why? When it comes to prescription drugs, how much a patch dispenses really matters, explains Çelik. They need to deliver a set dose — not more, not less. Patches typically lack such consistency. A microneedle patch for prescription medicines, he says, must deliver the same amount of drug "each and every time."

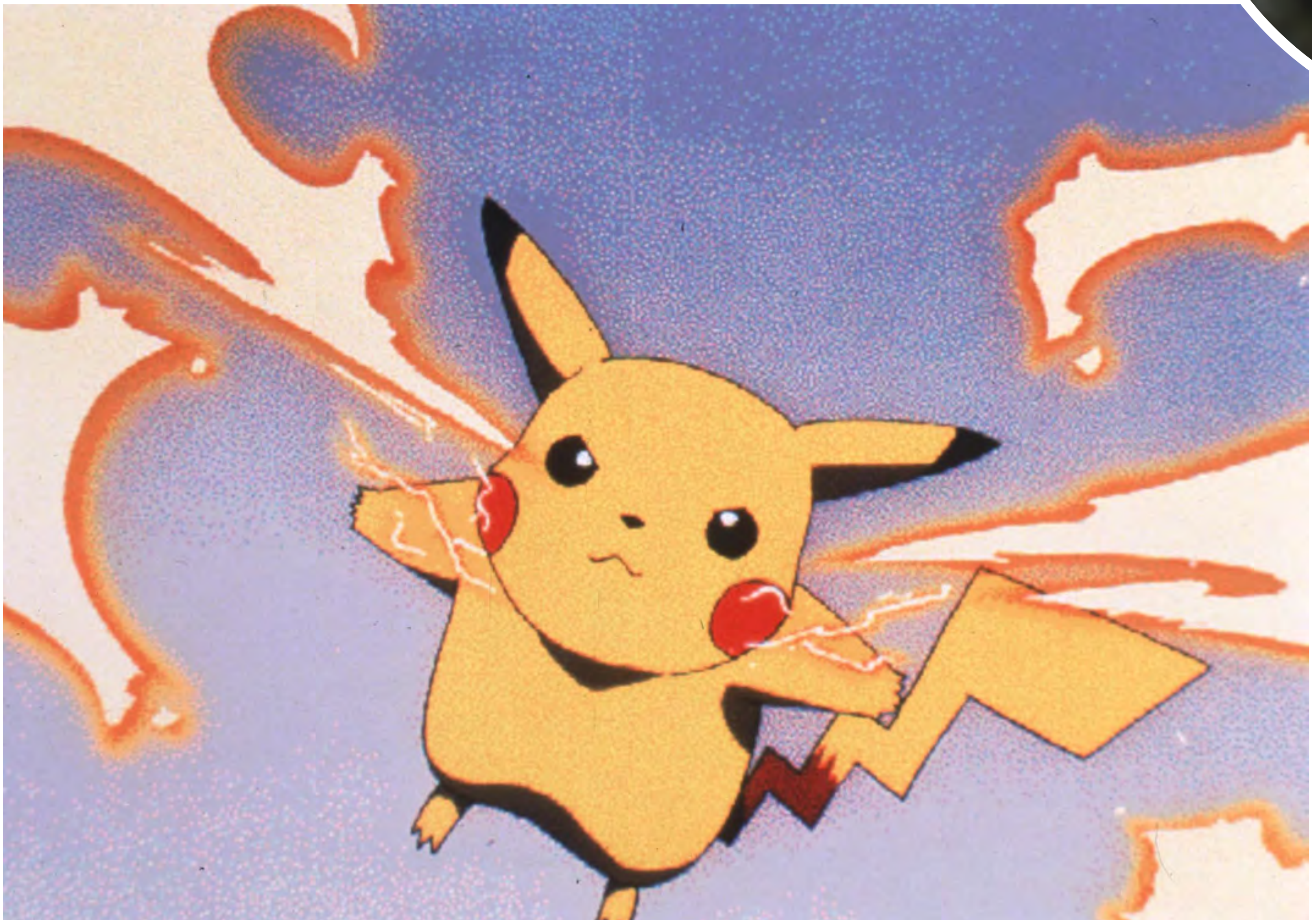
There's also a question about how big a dose they can dispense. For some drugs, the tiny needles may not be able to deliver enough to have the needed effect, says Çelik. In these cases, they may never fully replace hypodermic needles.
— Katie Grace Carpenter ◗

Clever geometry could help future pimple patches better stick to skin and deliver anti-acne treatments.

PHYSICS

Could a person ever wield lightning as a weapon?

Inspiration might be found in electric eels and laser-guided lightning



In the *Pokémon* series, Pikachu can aim electric attacks at enemies from its cheek pouches. In the real world, getting electricity to flow freely through the air would prove challenging.

PICTURELUX/THE HOLLYWOOD ARCHIVE/ALAMY; MARK NEWMAN/THE IMAGE BANK/GETTY IMAGES

In the Pokémon world, Pikachu is a chubby yellow mouse. It may look cute and harmless — but don't be fooled. When its red cheeks start sparking and it whips out its lightning-shaped tail, Pikachu can fry its opponents with a giant surge of electricity. Its signature move, *Thunderbolt*, is said to carry 100,000 volts of power.

In fiction, electricity seems easy to control. But in the real world? Not so much. That's because electricity is a flow of tiny, charged particles. Those particles usually need a clear path, such as a wire, to travel along. Getting electricity to arc freely through the air — on command and in a chosen direction — is much, much harder.

But nature offers some examples of how to generate electricity on the fly. And engineers already have some surprising tricks up their sleeves to wrest control over lightning. From the waters

Electric eels can leap partway out of water to headbutt threats in the air, delivering more powerful shocks than in water.

of the Amazon to the tops of Swiss mountains, researchers are learning how to make and direct electric power.

SHOCKING CREATURES

In the wild, some animals can generate their own electricity. That's especially true of fish. Shocking swimmers include electric rays, electric catfish and the most powerful of them all: the electric eel. This long, snakelike fish lives in the Amazon River. Adult electric eels can grow up to about 2.5 meters (8 feet) long and weigh as much as 18 kilograms (40 pounds).

Like Pikachu, electric eels can choose exactly how and when they want to use their electricity. "Electric eels have amazing control over their superpowers," says Raimundo Nonato Mendes-Júnior. He's a biologist at the Chico Mendes Institute for Biodiversity Conservation in Brasília, Brazil.

Electric eels send out weak zaps to find prey or talk to each other. But when they need to defend themselves or attack, they can unleash a much stronger jolt. Their biggest shock can reach 860 volts, Mendes-Júnior and his colleagues have found. That's about seven times the electricity in a U.S. wall outlet.

The eels can do this thanks to thousands of special cells in their bodies called electrocytes. These cells work like tiny batteries. They're stacked in long rows, each with a positive and negative side. When the electric eel wants to strike, it sends a signal that tells all the electrocytes to fire at once. Then, a burst of electricity zaps into the water.

"Electric eels give lots of shocks, but they recover quickly," says Mendes-Júnior. That's because they eat often and are really good at turning food into electric power.

The animals' battery-like cells are impressive. But their zappy attacks still have nothing on Pikachu. To supercharge electrical powers in real life, we might instead tap into some of the biggest power surges on Earth: lightning storms.

AIMING LIGHTNING

Lightning forms when static electricity builds up inside a thundercloud. As the storm churns, tiny ice particles collide and swap electrons. This causes one part of the cloud to become packed with negative charge.

Normally, air is a poor conductor. That is, electricity can't easily flow through it. But when enough charge builds up in a cloud, it can start to break down the air around it. Electrons get ripped off their atoms, making a hot soup of free-floating charged particles called plasma.

Once plasma forms, it acts like a kind of invisible wire through the sky, says Jerry Moloney. He's a physicist at the University of Arizona in Phoenix. Lightning strikes when electricity zips along that invisible wire.

Lightning generally takes the easiest route to the ground. It often strikes the tallest object available, such as a tree or tower. But what if you want to catch lightning in a certain place and then send it somewhere else?

In 2021, scientists in Switzerland did just that. They used a high-powered laser to guide lightning during a thunderstorm. A laser is a super-focused beam of light that stays in a straight line. If it's powerful enough, its energy can knock electrons off air molecules. This helps it create a thin line of plasma in the air that lightning can follow.

When lightning struck near a Swiss mountaintop, it followed a plasma channel made by the laser about 50 meters (160 feet) to a lightning rod on a tower.

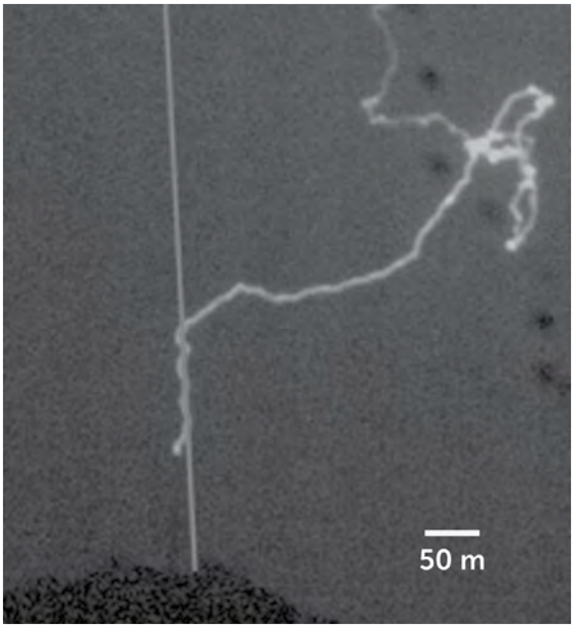
If Pikachu were to aim lightning in real life, it would need to make a plasma path like this. "In principle, you can fire the laser in different directions and create these 'wires' at different points in space," says Moloney. Then, if you didn't want to wait for a storm, all you would need is a big enough electric charge to send your own lightning down the line.

But don't try it at home. Moloney says, "I always joke that if you have a graduate student on the ground firing a laser, the student might evaporate if struck directly by lightning."

Good thing Pikachu is made of sturdier stuff.

— *Celina Zhao*

On July 24, 2021, fairly clear skies allowed a high-speed camera to capture this bolt of lightning. The image shows how a laser bent the bolt of lightning between the sky and a lightning rod atop a tower.



A. HOUARD ET AL/NATURE PHOTONICS 2023

HEALTH

What is skin?

This organ serves as soft, flexible armor for the body

The human body's largest organ might be a surprise. It's your skin. And it is an active, living tissue. Skin serves as tough but flexible armor to keep harmful microbes, chemicals or strong rays of light away from more sensitive inner tissues. At the same time, nerves within the skin relay important information about the world around us by sensing pain, textures and temperatures.

The skin you scrub in the bath or shower is only the outermost layer, called the *epidermis*. The epidermis is constantly shedding dead cells from its surface as new ones grow to take their places. Beneath that outer layer, the *dermis* contains blood vessels. An even deeper layer is called the subcutis. It stores reserves of fat that act as a cushion to help protect muscles and bones from bumps and falls.

Look closely at your nose in a mirror and you'll see what look like tiny pits on the skin. These are pores. Some 5 million pores pepper the entire epidermis, not just the nose. Hairs grow from the dermis up and out of each pore. (Most of these pores and hairs are too small to see.)

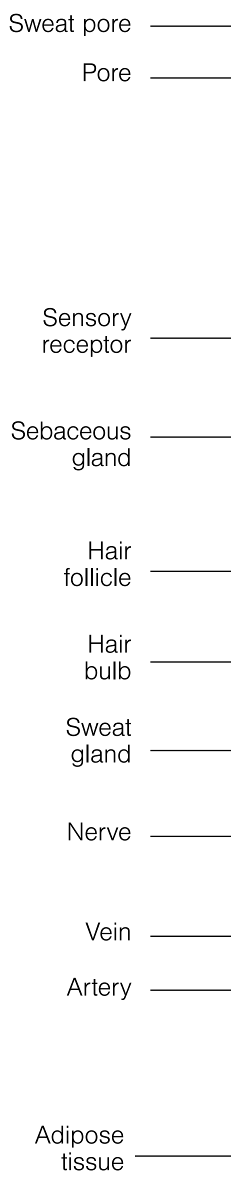
Organs called glands sit just below or near the pores. Some of these glands produce sweat to help cool the skin. Sebaceous glands pump *sebum*, an oily substance, up to the surface of the skin. Sebum is important for skin health. It forms a protective barrier that holds in moisture and locks out many disease-causing microbes.

A clogged pore that hasn't closed up completely can form a tiny pimple called a blackhead. A whitehead happens when the pore seals up and swells with inflammation. Some people may also develop hard lumps, called papules or nodules, or oozing pus-filled sores called pustules or cysts.

Teens going through puberty get pimples, known as acne, more often — and more severely — than anyone else. Blame hormones. They tend to make glands in the skin boost their production of sebum. That bonus oil means there's a higher chance that pores will clog.

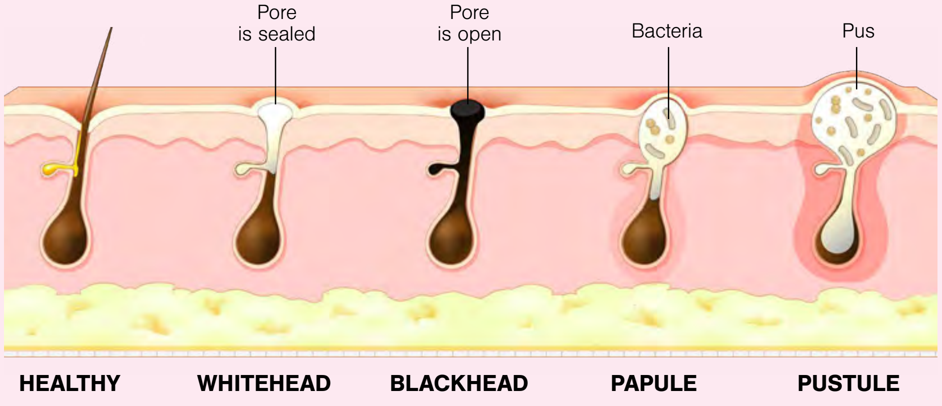
What's more, *Cutibacterium acnes* bacteria live on people's skin and dine on sebum. Some types of this bacterium promote the development of pimples. So the more of this greasy substance that builds up on the skin and in the pores, the more of these germs can grow. This could promote the development of zits.

— Kathryn Hulick

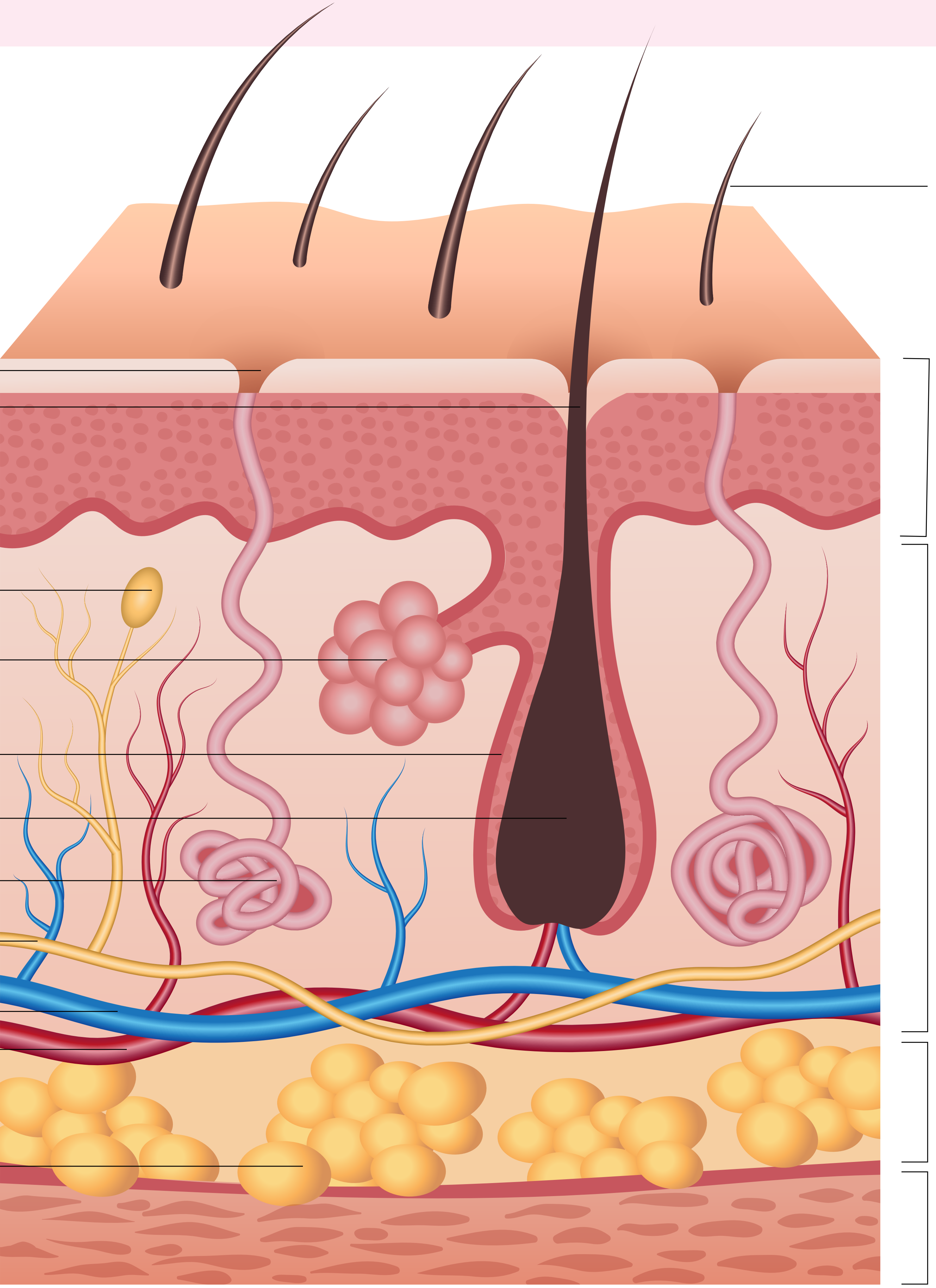


WHAT IS ACNE?

When skin pores get clogged, infected or inflamed, the result is painful bumps called acne. Over-the-counter skin cleansers (such as Clearasil or Stridex) can help a mild outbreak. For more serious cases, doctors can prescribe stronger lotions or drugs or even use lasers.



DESIGNUA, ONYXPRJ/SHUTTERSTOCK


Hair
Epidermis
Dermis
Hypodermis
Muscle layer

ANIMALS

Primates may not have evolved in the tropics

Surprisingly, the earliest relative of humans, apes and monkeys might have lived in cold places

Today, primates, including monkeys and apes, are common in the hot, humid tropics. That's led people to think that primates evolved in such places. But some primates live in cold places, including these macaques that dwell in Japan.

Crack open a book on primates — the group that includes humans, apes, monkeys and lemurs — and you'll likely read that these creatures evolved in hot, humid places. This old idea appears again and again, everywhere from scientific papers to YouTube videos. But a new study suggests that primates actually evolved somewhere cold.

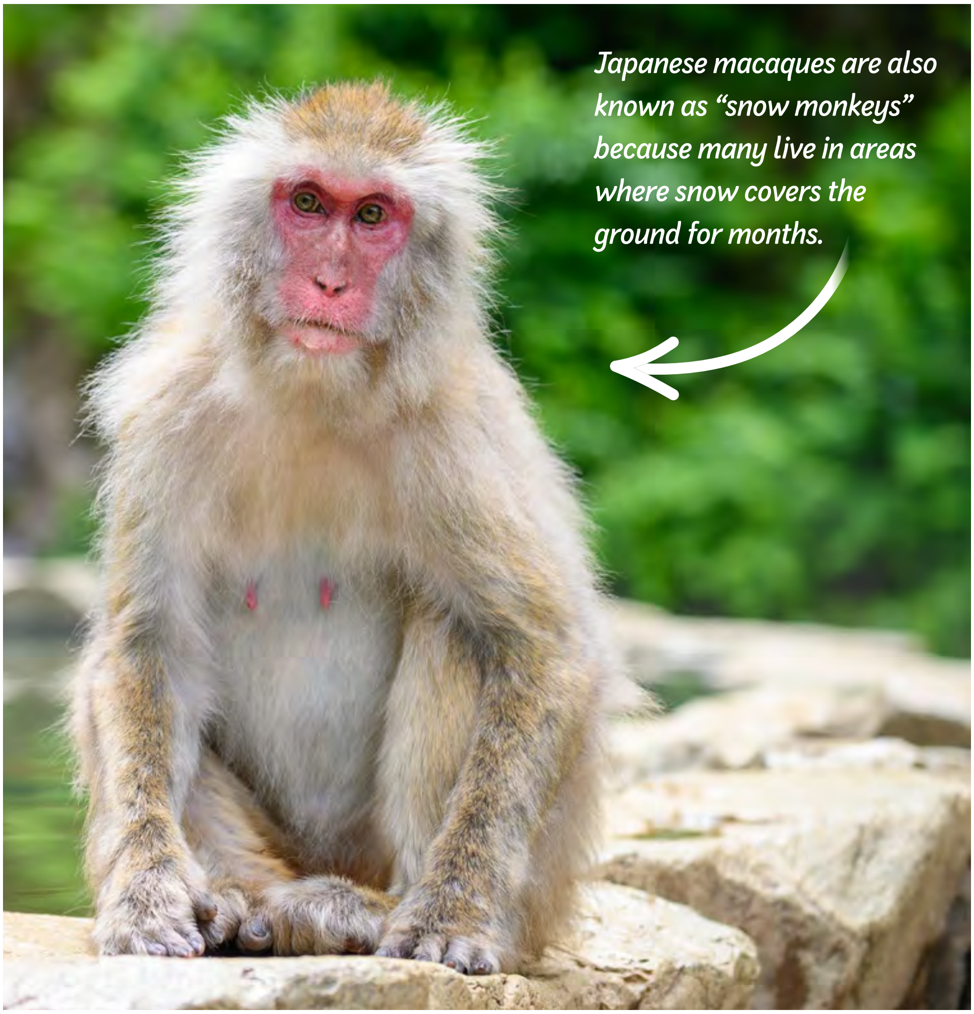
People had a couple of reasons to suspect primates got their start in the tropics. For one thing, many species of primates today live only in tropical forests. For another, many primates have thumbs that can grasp things. That would be handy for climbing trees, hinting these animals' ancestors may have lived in forests.

But fossils tell a different story. "Most of the fossils of primates have been found not in the tropical regions," says Jorge Avaria-Llautureo. He's an evolutionary biologist at the University of Reading in England. Most fossils of ancient primates are found in parts of North America, Europe and Asia that weren't warm and rainy when the animals evolved.

Avaria-Llautureo and his colleagues dug into the huge evolutionary family tree of primates. They figured out where the ancestors of various primate species would have lived based on locations of their descendants' fossils. The researchers worked their way back to find where the common ancestor of all primates lived.

Computer models of Earth showed what type of climate once existed in each place primates had evolved. It was a diverse mix of climates. That's not what you'd expect to see if ancient primates lived only in the tropics, Avaria-Llautureo says.

The first primate, which evolved 66 million years ago, most likely lived in a cold climate. "This is the most controversial result," Avaria-Llautureo says. The team found that primates likely originated in North



Japanese macaques are also known as "snow monkeys" because many live in areas where snow covers the ground for months.

TWENTY47STUDIO/MOMENT/GETTY IMAGES

America and spread from there across the world. Only some 20 million years later did primates really take off in the tropics.

The findings appeared in the *Proceedings of the National Academy of Sciences*.

Avaria-Llautureo and his colleagues did many tests to see whether their results held up. “When we were sure about it, it was very exciting,” he says. But that doesn’t mean that this is the last word on where primates evolved. It’s possible future studies will turn up new ideas. “There is no final answer in science.”

— *Carolyn Wilke* ◗

DATA DIVE

1. Look at Figure A. Which four continents have a high density of possible locations for the common ancestor of primates?

2. Look at the locations where dots are clustered. What type of climate existed at each location 66 million years ago?

3. Look at Figure B. How many primate family tree branches were there 66 million years ago? How are they spread between different types of environments?

4. How long ago did primates first appear in tropical environments?

5. During which time periods were primates not living in cold environments?

J. AVARIA-LLAUTUREO *ET AL*/*PNAS* 2025

PRIMATE PLACES

FIGURE A

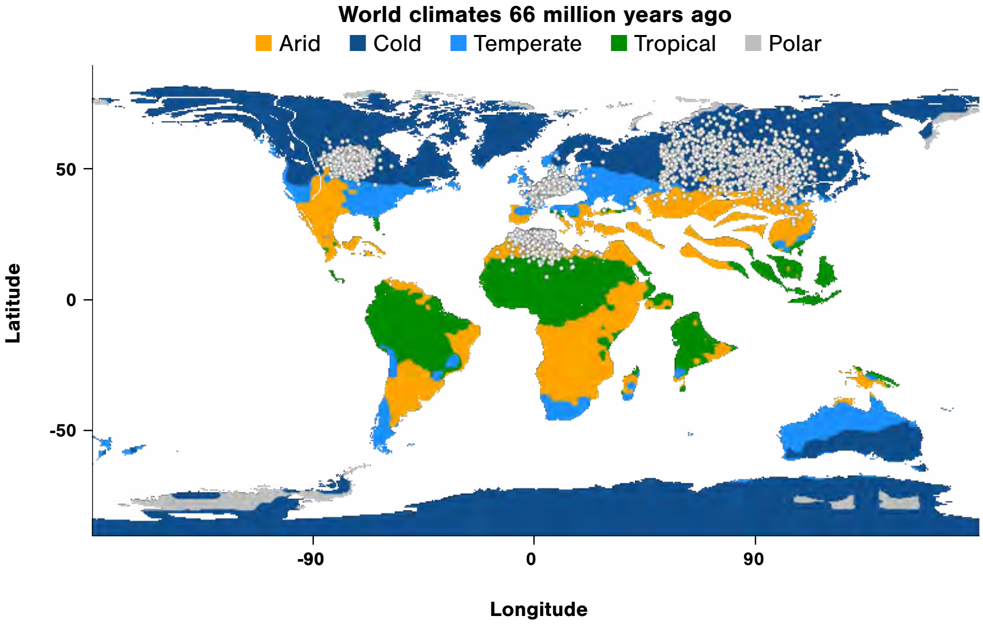
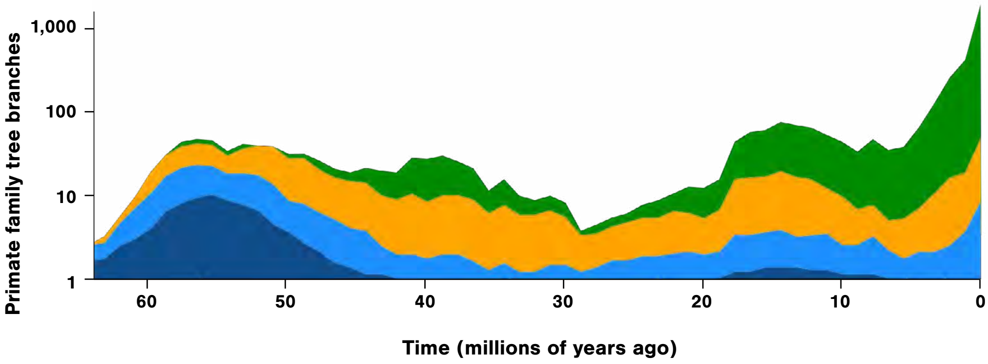


FIGURE B



By looking at where fossils of primates have been found, researchers worked out where their ancestors would have lived. They went back all the way to the common ancestor of all primates. They found all possible locations for the common ancestor (white dots in Figure A). Models showed what the climate would have been at these locations 66 million years ago, when the first primate evolved. The analysis also showed how primates have spread across different types of climates since they evolved (Figure B). The value on the y-axis is the average value over a 1 million-year-period centered around the time on the x-axis. At each point along the timeline, the wider a color band is, the more branches of the primate family tree lived in that climate.

ANSWER

Take a peek inside fluorescent ferns

Award-winning micro-photo reveals inner workings of plants

This kaleidoscope-like image shows spore-containing structures (blue/purple) from a tropical fern (*Ceratopteris richardii*) at 25x magnification. The top pod holds spores with brainlike shells. The center pod remains unopened, and the lower pod is empty. Tissues (orange) from the ferns' leaflike fronds surround them.

Kaleidoscopic pop art? No, these are the spores of a tropical fern. Spores are cells that some plants, fungi and bacteria use to reproduce. Like seeds, they're often spread by the wind or small animals.

Igor Siwanowicz made the spores in this image look fluorescent using lasers in a confocal microscope. This type of microscope blocks out-of-focus light. That helps it produce crisp images.

This image shows three podlike structures. Known as sporangia, these structures are where a fern's spores grow. Siwanowicz sliced the pods in half with a small razor. This revealed what was inside. The top pod holds spores with shells that looked a bit like brains. The center pod remains unopened. The bottom pod is empty. It likely burst and dropped its spores while he was prepping for the photo, Siwanowicz says. The frond tissue of the surrounding fern (*Ceratopteris richardii*) is orange.

Siwanowicz studies anatomy at the Howard Hughes Medical Institute's Janelia Research Campus in Ashburn, Va. The shot was one of 71 striking photos honored in the 2025 Nikon Small World microphotography competition. Siwanowicz especially enjoys the chaos of the image, which won fifth place.

"Microscopy images are very abstract and sometimes alien-looking," says Siwanowicz. "They're confusing. But sometimes confusion creates this urge to find out more."

— *Carly Kay*

IGOR ROBERT SIWANOWICZ

INSIDE THE MINDS OF YOUNG SCIENTISTS

Thermo Fisher Scientific Junior Innovators Challenge finalists answer three questions about their science

Science competitions can be fun and rewarding. But what goes on in the minds of these young scientists? Lia González and Anya Terón Villodas, finalists at the 2025 Thermo Fisher Scientific Junior Innovators Challenge, share their experience.

Q Did anything about your project surprise you?

A Anya and Lia learned that ants sometimes invade beehives to steal their food. They read that liquid from the buds of African tulip trees — an invasive species in Puerto Rico, where they live — may work as a natural insect repellent.

The pair only set out to test whether ants would enter a repellent-sprayed model hive. They were delighted to see bees moving into the box sprayed with the ant repellent. "It was actually an amazing encounter," Anya says. "We now for sure know that the African tulip liquid — which is our exterminator for ants — does not affect, at all, the bees." That should mean it's safe to use on hives.

Q What is your advice for choosing a research partner?

A "Pick someone you're actually compatible with and you know how they work," Anya says. For instance, she loves to talk and brings a lot of enthusiasm to discussing ideas. Lia is more straightforward and keeps them on topic. Those differences create great chemistry, rather than friction, because they care about each other.

Q Any advice for research newbies?

A "Be unique. Be fun. Go crazy," Anya says. "Do something that maybe isn't what a lot of people are doing." That's where true discovery awaits.

Thermo Fisher Scientific Junior Innovators Challenge finalists

Lia González and Anya Terón Villodas

Lia, 14, and Anya, 15, found a natural solution to keep bees safe. When sprayed on hives, liquid from an invasive tree species kills off threatening ants but does not harm the bees. This pair of teen researchers did this work as eighth graders at Colegio Rosa-Bell in Guaynabo, P.R.

Thermo Fisher Scientific
Junior Innovators
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EXPLORE
OUR SOCIAL MEDIA

What is the hardest substance in the universe?
Why do we have nightmares?
How does soap kill germs?