Science News Explores

SEPTEMBER 2026

MAKING WAVES

Meet the world's biggest waves — and the mysteries behind them

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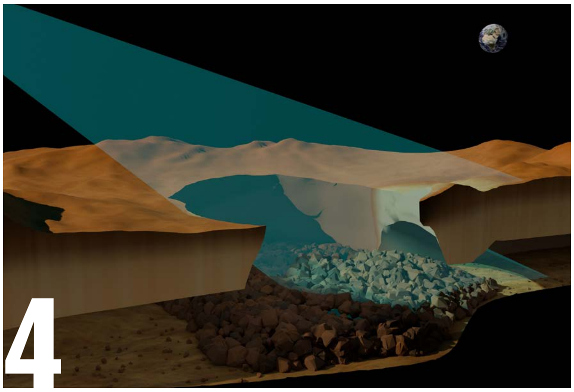
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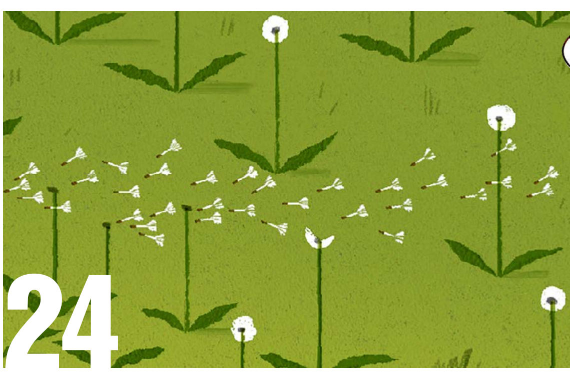
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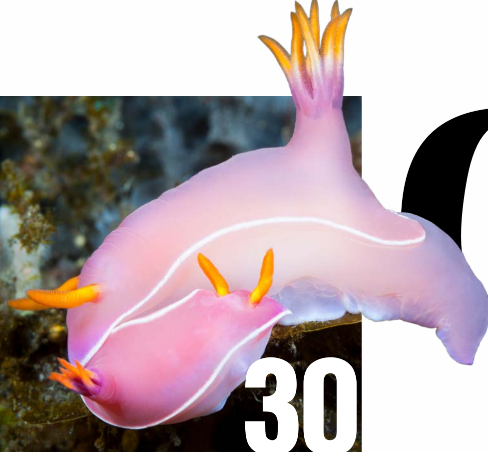

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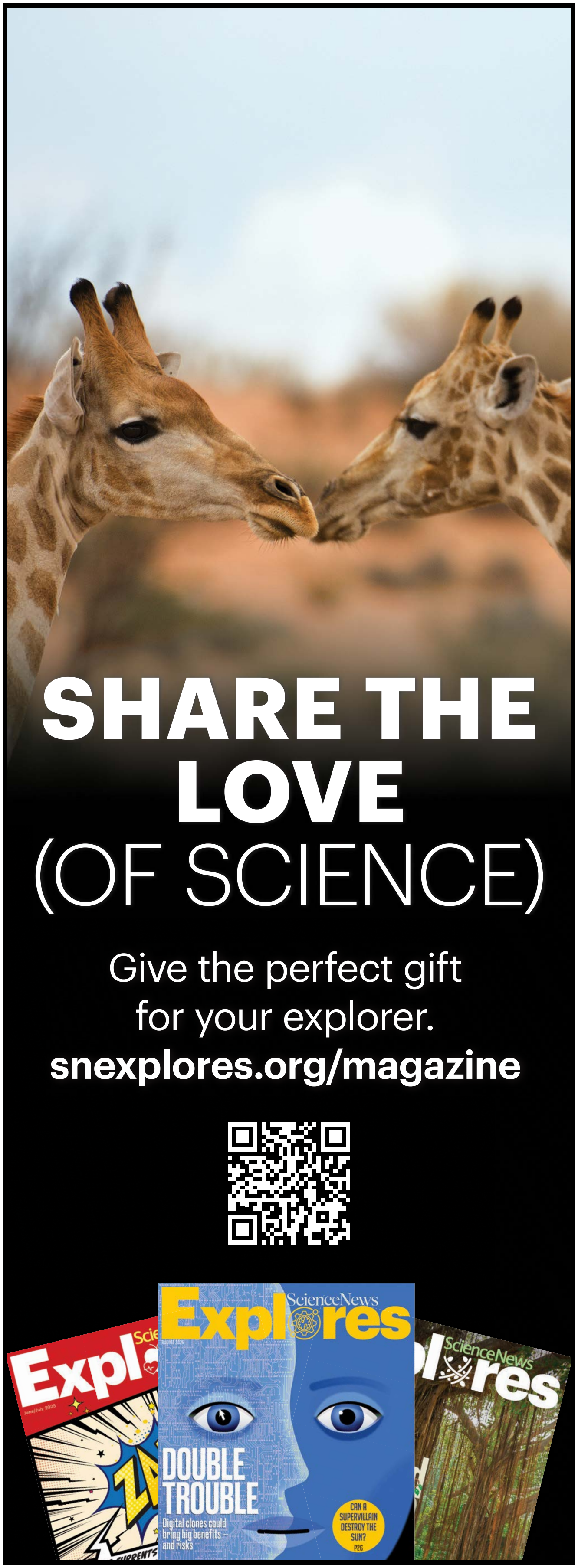

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Science News Explores
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Q Does antimatter exist?

— Mohammed R.

A “Yes, antimatter exists,” says *Science News* senior physics writer Emily Conover. “Antimatter just means a particle that is the opposite charge of a particle that we know and love.” An electron’s antimatter partner is a positron. And a proton’s partner is an antiproton. Antimatter is rare. But some natural processes, such as radioactive decay, can produce it. For instance, bananas, which contain tiny bits of radioactive potassium, periodically spit out positrons. “If you eat a banana, then you might have some antimatter created inside you,” Conover says. “But it’s not dangerous.” Whenever matter and antimatter meet, they annihilate each other. So as soon as a positron encounters one of the many electrons in your body, Conover says, “it just goes poof.” Scientists create and study antimatter by smashing particles together inside huge particle colliders. If you keep antimatter away from matter, then antiparticles can exist and “just hang out,” Conover says. In fact, scientists recently transported antimatter by truck for the first time. The trick was trapping antiparticles in electromagnetic fields so they couldn’t touch the walls of their container.

CERN

Q Why is space black?

— William C.

A Scientists have long pondered why space appears black despite being filled with stars. This problem is known as Olbers’ paradox. The paradox assumes that the universe is static, infinitely old and filled with an infinite number of stars. If that were all true, we should be able to see a star anywhere and everywhere in the night sky. That would make the sky uniformly bright. But the darkness of space is one of the reasons we now know that those assumptions don’t hold up. Scientists have determined that the universe is about 13.8 billion years old. Because light takes time to travel through space, we can only see starlight that has managed to reach us in that time. Light from the most distant stars and galaxies hasn’t had enough time to do so. The universe is also expanding. That means this distant starlight is stretched to wavelengths longer than what the human eye can perceive. If we could see infrared and microwave light, the night sky would appear much brighter.

Q How is tar made and what is it used for?

— Daniel T.

A Tar is a thick, sticky, black substance known for its durability and water resistance. It forms when organic materials, usually wood or coal, are heated to very high temperatures without much air. This process, called destructive distillation, produces leftovers, including tar. In a normal fire, such byproducts burn away. When oxygen is limited, they can instead be collected. Humans have been doing this for hundreds of thousands of years. “Tar is one of the single longest-spanning technologies,” says Paul Kozowyk. He studies ancient adhesives at Delft University of Technology in the Netherlands. Neandertals may have heated rolls of birch bark in small, covered pits and used tar as glue for stone tools. In the Middle Ages, people buried pine wood under dirt and grass to make tar to waterproof ships. Today, tar is made in industrial furnaces. Tar is used to repair roads, seal rooftops and make plastics. It’s even found in small amounts in skincare products and shampoos.

Correction: *On page 31 of the August 2026 issue, the times in Figure A are shown in local German time, not UTC.*

Do you have a science question you want answered?
Reach out to us on Instagram (@SN.explores), or email us at explores@sciencenews.org.

PHYSICS

Physics explains basketball sneaker squeaks

Wrinkling shoe soles create noise as players dash across the court

The sounds of a basketball game don't just include the smack of a bouncing ball, players' shouts and the cheers of a crowd. They also feature lots of squeaking sneakers. Shoes make these sharp sounds as players abruptly stop or turn. Now, physicists understand why.

High-speed videos reveal that as a shoe slides on a floor, it goes through a stick-slip motion. Parts of the shoe's sole stick in place as other parts slip forward. The shoe slips in bursts, as small regions of the sole wrinkle slightly and detach from the surface. The regular repetition of those pulses creates that squeak.

Adel Djellouli was part of a team that shared these findings in *Nature*. Djellouli is an applied physicist at Harvard University in Cambridge, Mass.

In their experiments, the researchers needed to see the sole of a shoe. So they scuffed it across a glass surface. Images from below captured the shoe's sole. The images were bright where the sole touched the glass and dark where the shoe pulled away.

As a shoe goes through its stick-slip motion, pulses of wrinkles travel along its sole. This is a bit like how a wrinkle might travel across a bedspread as you snap it into place. But in the shoe, the pulses repeat about 4,800 times a second.

When a wrinkle meets the edge of the shoe, it smacks the surrounding air. That changes the air pressure. Repeated smacks make a regular change in air pressure, creating a sound wave.

The researchers also tried sliding blocks of rubber across the glass. This revealed that a sneaker's tread needs ridges to make the sound. As flat rubber moved across the glass, it made chaotic pulses at uneven intervals. That produced a muddled noise, not a clear-pitched squeak.

Ridges guide the pulses along a shoe's sole and help organize them. That's what makes the pulses regular.

Djellouli's team confirmed this by sliding a rubber block with ridges across the glass. It made a clear squeak, just as a shoe would.

The researchers discovered other fun facts about sneaker squeaks, too.

The thickness and stiffness of a rubber block or a shoe sole, for instance, is what sets a squeak's pitch. That discovery suggests a way to make silent shoes: Tune that squeak to an ultrasonic pitch. Humans can't hear sounds that high. Shoemakers could do this by making the soles of their shoes thin. Or they could tweak the material used to make the shoe's sole.

Those changes might not improve athletes' game, though. Plus, dogs can hear ultrasonic pitches.

Johni Broome (right) of the Auburn Tigers drives toward the basket around Mouhamed Dioubate of the Alabama Crimson Tide during an NCAA game in 2025 — a move sure to have been accompanied by lots of sneaker squeaks.

BRANDON SUMRALL/STRINGER/GETTY IMAGES NORTH AMERICA

So your "silent" sneakers might be pretty annoying for your pet, Djellouli says.

The researchers also designed rubber blocks that squeaked at specific pitches. Then, they used the blocks to play "The Imperial March" from *Star Wars* — the tune that plays whenever Darth Vader comes on screen. That revealed another scientific truth. Darth Vader would have seemed much less scary if he had squeaky shoes.

— EMILY CONOVER

HEALTH

988

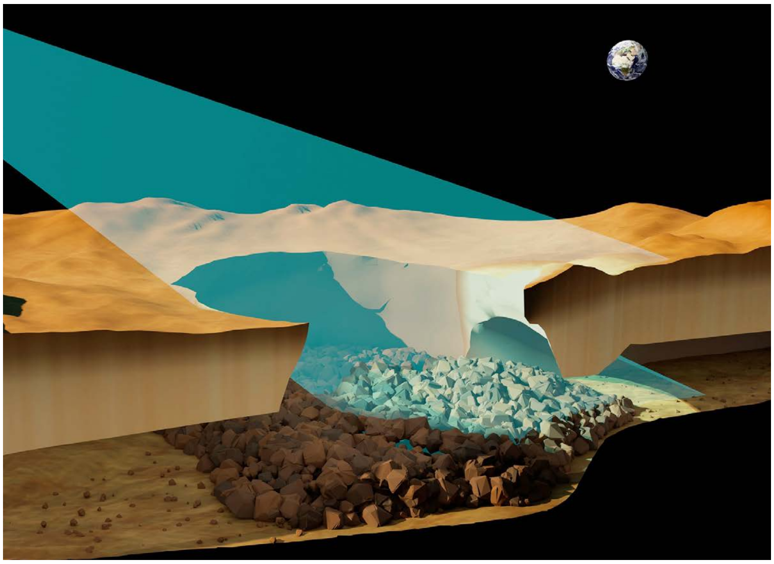
Since 988 replaced the 10-digit suicide lifeline in the United States, the suicide mortality of those aged 15 to 34 was *11 percent* lower than predicted. If you or someone you care about may be at risk of suicide, the 988 Suicide and Crisis Lifeline offers free, 24/7 support, information and local resources from trained counselors. Call or text 988 or chat at 988lifeline.org.

Source: V.R. Patel, M. Liu and A.B. Jena/*JAMA* 2026

PLANETS

Venus may have huge, underground lava tubes

A fresh look at old data revealed a previously unknown, kilometer-wide volcanic cave



NASA's Magellan probe mapped Venus' surface in the 1990s. A review of radar images from that mission revealed the collapsed roof of an underground tunnel where lava once flowed.

RSLAB/UNIVERSITY OF TRENTO

Venus, though hidden from view by dense clouds, is slowly giving up some of its secrets. One of them is the first detection of a lava tube beneath its surface.

This kind of cave forms from the flow of molten lava. Once that lava drains away, an underground tunnel remains. To make this discovery, scientists took a fresh look at radar images of Venus.

NASA's Magellan spacecraft mapped the planet's surface in the early 1990s. Scientists reanalyzed the decades-old data with special imaging techniques. They were scouting for telltale "skylights" — openings that hinted a lava tube was below.

Their search turned up a skylight near a massive broad and flat volcano called Nyx Mons. (Named for the ancient Greek night goddess, its name in Latin means "Mountain of Nyx.") The researchers shared the finding in *Nature Communications.*

The collapsed skylight was about 150 meters (490 feet) deep. It opened into an empty lava tube at least 375 meters (1,230 feet) deep. The researchers estimate the lava tube may be much, much broader — up to one kilometer (0.6 mile) wide.

That's larger than any lava tube found on Earth or Mars. It's the size of some seen on Earth's moon, where the gravity is much lower. Lower gravity makes it easier for large lava tubes to form. So here's a new mystery: Why would those on Venus be so big when its gravity is similar to Earth's? And finding one lava tube on Venus suggests there could be more.

The newest discovery will influence two future Venus probes. NASA plans to launch its VERITAS mission in June 2031. The European Space Agency expects to launch its EnVision mission later that year.

— TOM METCALFE

BRAIN

How blind people use echolocation to navigate

Repeated echoes help some blind people sense nearby objects

Watch a video to learn more about echolocation:

Blind people often navigate the world using a cane, guide dog or wearable GPS. But some have another strategy: echolocation. That's the ability to sense nearby objects using sound. A new study in *eNeuro* shows how this technique helps echolocators get around.

These people make a sharp clicking sound with their tongue. Then they listen for its echo to sense objects around them. New brain-activity data show that with each click, echolocators improve these mental maps of their environment.

Those echoes can reveal the location or size of nearby objects. In some cases, they might even indicate texture. (Bats use this same process to find their way.)

Many studies have shown that in people, echolocation excites parts of the brain that help with sight. They've also shown that echolocation improves a lot with practice.

This "is not magic," says Santani Teng. He and co-author Haydée García-Lázaro work at the Smith-Kettlewell Eye Research Institute. It's in San Francisco, Calif. The two study how our brains process information.

"Echolocators have a truly remarkable skill, with real-life benefits," he says.

To better understand human echolocation, Teng and García-Lázaro recorded clicks and echoes. They designed these echoes to act as if they were bouncing off a nearby object. Then, the scientists compared how two groups responded to these recordings.

The four blind people in one group were all experts in echolocation. The other group of 21 people could see well. They also had no experience with echolocation.

Each volunteer listened to sets of recorded clicks followed by their echoes. After each set, these people were asked whether an object had been to their right or left. As they listened, electrode caps recorded their brain activity.

The blind echolocators scored far better than those who could see. Their brain data showed that each click-echo pair gave new details about the surroundings. Instead of relying on a single snapshot, echolocators combined these additional details over time.

García-Lázaro says she and Teng want to learn more about "what exactly makes better echolocators." She's especially curious about how experts learn to ignore the click and focus only on its echo.

— Nora Bradford

Many blind people use canes, wearable GPS devices or guide dogs (above) to get around. Some, though, rely on the ability to detect objects using sound, known as echolocation.

JIM CRAIGMYLE/STONE/GETTY IMAGES; TRACEE TIBBITTS

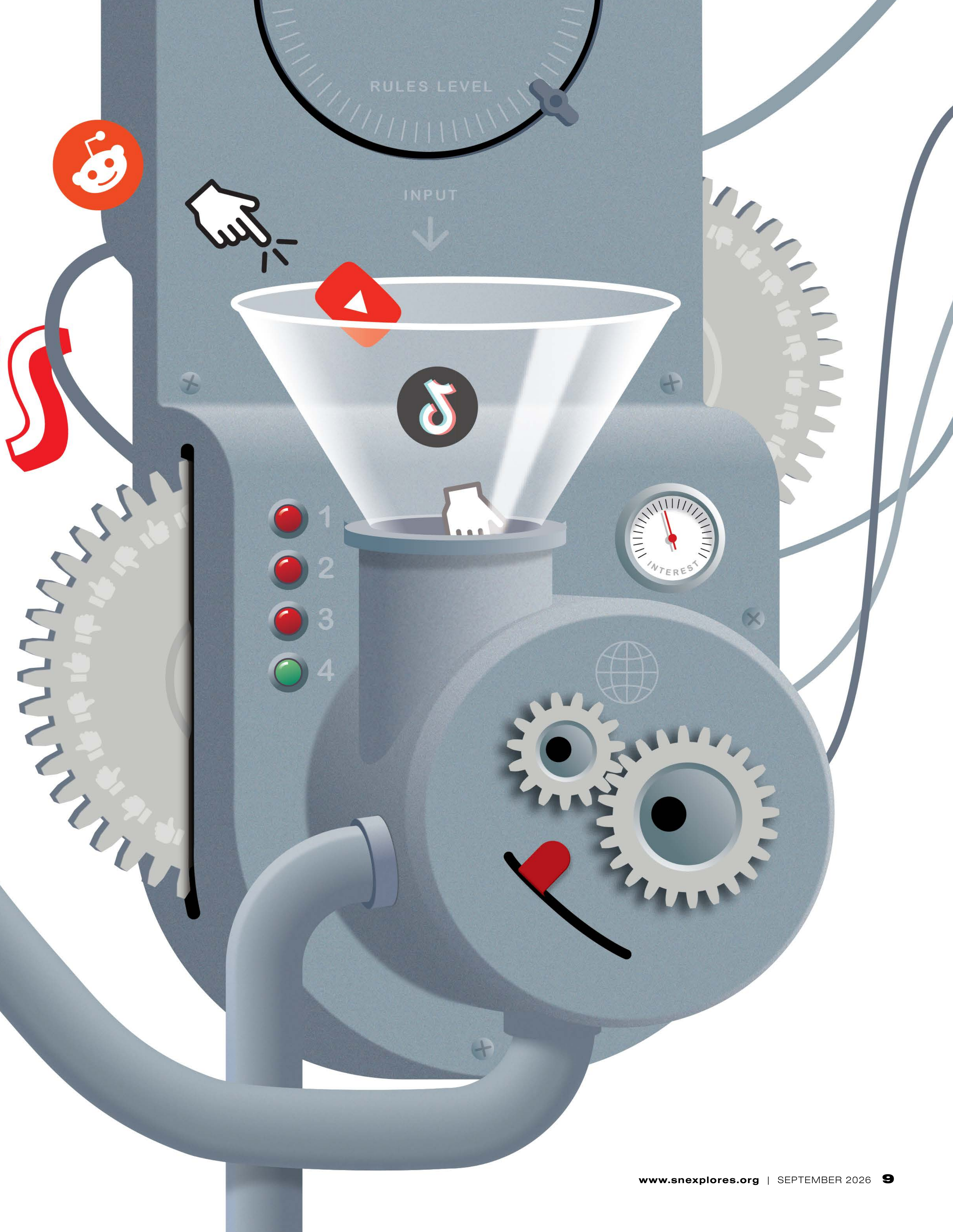

Think you know what you're seeing? Find out on page 32

UNDERSTANDING ALGORITHMS

These ‘recipes’ are behind everything from choosing a dog to what’s on social media

BY **WENDY ORLANDO**

STEVE MCCRACKEN


RULES LEVEL
INPUT
1
2
3
4
INTEREST

Algorithms are incredible tools. When run by computers, they can fly airplanes without human pilots. They can figure out how much insulin a teen with Type I diabetes needs minute to minute. They even decide what social media shows you — and billions of other people.

Your brain creates algorithms, too. It uses them to decide where to stand on the soccer field when you're playing defense, map the best bike route to school or choose between multiple-choice options on a test.

"An algorithm is just a fairly precise list of instructions to accomplish a specified task," says Noah Giansiracusa. He's a mathematician at Bentley University in Waltham, Mass.

Algorithms have been around since the beginning of human history. But when people use the word "algorithm" these days, they're often referring to algorithms online. These can have a huge influence on us. Large companies have created computer algorithms that decide what users see on social media and other websites.

This rock lists 282 rules governing Babylonian society, carved about 3,800 years ago in cuneiform script, an ancient writing system. Called Hammurabi's Code after the king who made it, it's an early example of an algorithm.

Online algorithms can help you find the content you want more quickly and reliably. But they can also treat you like a preschooler, assuming they know what you want better than you do. Algorithms may try to push you into doing what their creators want, even if it's far from what you want.

You are not powerless in this, Giansiracusa says. He describes why in his book, *Robin Hood Math: Take Control of the Algorithms That Run Your Life*. Algorithms are often at work behind the scenes online. But you can learn how they work and how they often try to influence you.

"If you know about algorithms," says Giansiracusa, "you can tailor them for you." That way, he says, they can actually help you — not just some big company.

A SIMPLE ALGORITHM

Many of the algorithms behind social media and other sites work like recipes. When using a recipe, you follow a list of steps that combine ingredients (inputs) to make a desired dish (output). In cooking, some ingredients are more important than others. You need flour to make muffins, for instance. But nuts are optional.

The mathematical algorithms that computers use to make decisions work in a similar way. They also have inputs of varying importance or "weight." More important inputs have larger weights. Less important inputs have smaller weights.

Imagine you want to get a dog, but you don't know what type. You can make an algorithm to help you decide. Here's an example from Giansiracusa's book.

"Look for websites that rank dogs ... on a range of factors," Giansiracusa wrote. Factors could be how good the dog is with kids, how much exercise it will need or how good a guard dog it is. Those factors are your inputs. Then, "decide how much each of the factors matters to you." If you think each factor is equally important, you'd give each a weight of 1.

Now consider different dogs you might adopt. Maybe a golden retriever, a Yorkshire terrier or a St. Bernard. Rank them on each factor, where 3 is the best and 1 the worst. A golden retriever might get a 3

ANA_MALEE/SHUTTERSTOCK; JSP/ISTOCK/GETTY IMAGES PLUS

"IF YOU KNOW ABOUT ALGORITHMS, YOU CAN TAILOR THEM FOR YOU."

— NOAH GIANSIRACUSA

for being best with kids, while the Yorkie gets a 2 and a St. Bernard a 1. Now rank each dog on guard-dog skills and exercise needs.

Multiply each dog's good-with-kids rank times the weight you chose for that factor. Do the same for guard-dog skills and exercise needs. Then add up the three products in each row to get one score for each dog. (In math, this is called a "weighted sum.")

If all factors have equal weights, the St. Bernard might score highest. "If we put a little more weight on safety with kids, the golden retriever jumps into the lead," Giansiracusa wrote.

Pretty doable, right? This is the model for many algorithms.

YOU ARE THE INPUT

Algorithms have exploded online. They determine what appears on your social media feeds, including Instagram, TikTok and Snapchat. They also power sites that recommend content, such as Netflix, YouTube and Roblox. The content that algorithms decide to show users could be words, videos, photos, music, video games or products.

Algorithms can be amazingly helpful. Before we can blink, they sift through enormous piles of information much too large for a human to handle. Then, they give us the info we seek — or that would likely interest us. As in our dog-choosing algorithm, online systems do this (at least in part) using weighted sums.

The inputs for online algorithms are probabilities, Giansiracusa explains. Each is the probability or likelihood that you will engage with a post in a certain way. The probability you'll share a post is called P_{share}, which might be different from the likelihood that you'll comment on it, $P_{comment}$.

All the probabilities are numbers that the algorithm estimates. How? It analyzes data. *Your* data.

DOG ALGORITHM TABLE 1: EQUAL WEIGHTS

Breed	Good with kids? (weight 1)	Guard dog? (weight 1)	Exercise? (weight 1)	Weighted sum
St. Bernard	1	3	3	7
Golden retriever	3	2	1	6
Yorkshire terrier	2	1	2	5

Three dog breeds (one in each row) are ranked for three different factors (the middle columns), where 3 is the best and 1 the worst. For each row, each factor's rank is multiplied by its weight, and then everything is summed up. That weighted sum ends up in the rightmost column. If all weights are equal to 1, St. Bernard is the best of these dogs for you.

DOG ALGORITHM TABLE 2: UNEQUAL WEIGHTS

Breed	Good with kids? (weight 2)	Guard dog? (weight 1)	Exercise? (weight 1)	Weighted sum
St. Bernard	1	3	3	8
Golden retriever	3	2	1	9
Yorkshire terrier	2	1	2	7

Here "Good with kids?" is weighted 2. Now the golden retriever becomes the best of these dogs for you.

ERIC ISSELEE/SHUTTERSTOCK

"Algorithms track what you search for, click on, watch, follow, like, share, comment on — and even how long you spend viewing certain posts," explains Myojung Chung. She's an expert on journalism and media innovation at Northeastern University in Boston, Mass.

"Social media algorithms are shaped by nearly every aspect of your online behavior," Chung says. "This begins with your basic demographic data — such as your age, location, gender and racial or ethnic identity."

Armed with those data about you, a social media algorithm calculates how likely you are to engage with some post. As with selecting a dog, it then multiplies each probability by its weight and sums them up. This produces a single number, or score, for each post. The top posts in your feed will be the ones having the highest scores.

Why this focus on engagement? It has to do with the algorithm's goal.

As users, we may want social media to show us what our friends have been up to or serve us the latest funny memes. The company behind a social media app has its own goal. These two goals may be different — maybe even directly in conflict with each other.

IT'S ALL ABOUT ATTENTION

Is the goal of social media platforms to entertain, inform and satisfy us? Not really.

Companies are trying to make money from our time on their platforms. They give us the apps for free — then get money from ads. Other companies (for example, Nike or H&M) pay social media companies to place ads for their products right next to — or even within — our feeds.

Product makers will pay more if their ads are shown to users who are more likely to click on them. "The more time you spend on the app, the more ads you will see," Giansiracusa explains, so the more likely you are to eventually click on one.

The bottom line is that social media companies make more money from ads when you stay on their platforms longer. The goal of their algorithms becomes keeping you on their sites as long as possible.

A user's goal is different. "I never log into TikTok saying, 'My goal today is to spend as many minutes as possible on this,' " jokes Giansiracusa. "It's to be entertained." On Facebook, he says, "I want to see family pictures."

As a result, users and app owners frequently find themselves in a tug of war. As users, we try to make our own decisions, while social media companies try to reel us in by giving us posts we are likely to click on. This can affect us negatively, and not just by keeping us online longer than we had planned.

Social media apps serve up many posts similar to what we have clicked on in the past. They also feed us posts that people similar to us have clicked on. This can cause our horizons to narrow. We see more of the kinds of things that we've seen before. And we may feel pressure to like what others do.

Plus, any content that is shocking or causes strong emotions gets clicked on a lot. So algorithms tend to push that content on users. Such posts can easily be fake. Social media is known to contain lots of misleading and false information.

Remember that the algorithms are not trying to affect you in any way, good or bad. They're just trying to determine what posts will keep you clicking.

An online algorithm "doesn't care if I'm entertained or if I'm nauseated," Giansiracusa says. It couldn't care less, he adds, if I'm just scrolling and "feel horrible but I can't turn away." It's not human. It doesn't truly understand your wants or needs. It has no morality. All it does is calculate which posts are most likely to get your attention, then feed them to you, Giansiracusa says.

MAKING ALGORITHMS WORK FOR YOU

Mold your feeds. Don't just accept what the algorithm is serving you. Follow accounts that you want to see, especially those that inspire or educate you. Unfollow those that are more negative.

Use large platforms sparingly. Try not to spend most of your screen time on big social media sites. When you find creators you like, look for their content outside of social media, on- or offline.

Give feedback carefully. Social media algorithms can interpret any feedback as a sign to send more posts like it your way. So if you don't like something, give NO feedback. Don't like it. Don't comment on it. Don't rewatch it. Just ignore it.

Practice identifying fake news with a friend. Compare fake and real videos or posts, and talk with each other about how to spot a fake.

Use helper tech. Some apps, like Opal, Forest, Onesec or Freedom, let you track your social media use or set time limits.

Delete or offload apps from your phone. This can help especially in stressful times, such as during exams.

“SOCIAL MEDIA ALGORITHMS ARE SHAPED BY NEARLY EVERY ASPECT OF YOUR ONLINE BEHAVIOR.”

– MYOJUNG CHUNG

Social media algorithms use your previous interactions with posts to calculate which new posts are most likely to get your attention.

AN UPHILL BATTLE

We all need to have a say in what see. But when you’re stuck in a scroll, it can feel impossible to get offline, or even to influence what your feed shows you.

By altering your online behavior, you can take back control, Giansiracusa noted in his book. “You can influence the Ps — the estimates of your engagement probabilities.”

It isn’t easy. For starters, each platform decides how much weight to assign P_{share}, $P_{comment}$ and other probabilities. And remember from the dog example, the weights of each input can greatly change what the algorithm recommends.

What’s more, “we don’t know what’s in the algorithms or exactly how they’re weighting [their inputs],” Robbie Torney points out. He evaluates the safety and helpfulness of AI and digital platforms for Common Sense Media. This organization works to improve the online experiences of children and teens.

Finally, social media algorithms “are always changing,” Giansiracusa says — “changing without our knowledge.”

Kyle Chayka sums it up in his book, *Filterworld: How Algorithms Flattened Culture*. On any given day, he wrote, users cannot fully understand what went into an algorithm’s recommendations. Why? “Their equations, variables and weights are not public. ... They are closely held trade secrets, almost like nuclear codes.”

HOMEMADE ALGORITHMS

Perhaps the most powerful way to make algorithms work for you is to design your own.

Maybe you’ll be choosing a college soon. You could start by reviewing data at popular college-guide sites. But don’t use their algorithms. Make your own! Select the inputs that matter to you. Those might be cost, a good theater program or a chance to do marine-science research. Apply a weight to each input and rank each school on each one. Then calculate some weighted sums and compare.

You can use the same approach to make other decisions too, from how to celebrate your birthday to what instrument to play in the school orchestra. When you take more control over your choices, putting more of your own thoughts and opinions into your life decisions, your decisions will feel better to you.

Algorithms are all around us, including in our heads. Now that you know how they work and some of their pitfalls, you can make them work for you.

READ MORE

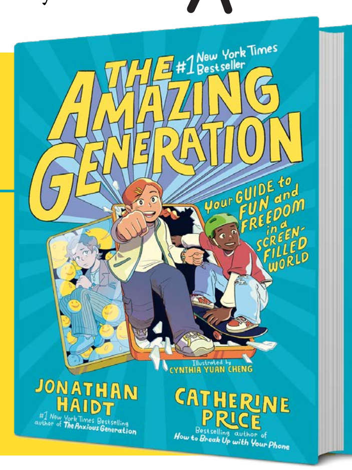
The Amazing Generation:

How to choose fun and freedom in a screen-filled world

By Jonathan Haidt and Catherine Price

Illustrated by Cynthia Yuan Cheng

For better or worse, algorithms are attention grabbing by design. With this book, discover science-backed skills to find balance beyond screens.



OATAWA/ISTOCK/GETTY IMAGES/PLUS; PENGUIN RANDOM HOUSE

Making W

Meet the world's biggest waves — and the mysteries behind them

BY STEPHEN ORNES

The morning of October 29, 2020, was cool and clear in Nazaré. This coastal town in Portugal is known for its waves, which are among the largest surfable ones anywhere. Every year, surfers flock here to ride down the monsters that rise out of the sea. On this day, the conditions were perfect for record-breaking waves.

Here, off the coast of Nazaré, Portugal, on October 29, 2020, Sebastian Steudtner set a record for the tallest wave ever surfed. That wave was 26.21 meters (85.99 feet) tall.

SOPA IMAGES LIMITED/ALAMY; BLUERINGMEDIA/SHUTTERSTOCK

In the early morning, a jet ski towed German surfer Sebastian Steudtner away from shore to where he met a towering wall of water. The jet ski zipped away to safety as Steudtner coasted up the wave right to its breaking point. Then gravity took over.

For 25 seconds, he tore down the wave. As the water broke above him, he raced to the side. Tears streamed out of his eyes because of the wind. “My face was melting,” he later told a Spanish newspaper. He had never felt faster on a surfboard.

Even for Nazaré, this wave had been a colossus. After Steudtner’s ride, scientists and surfing officials studied footage. They determined this wave had roared in at 26.21 meters (85.99 feet) tall. He had set a new record for the tallest wave ever surfed.

Extreme waves rise from waters around the world. In some places, like the coast of Portugal, they’re the norm. On average, Nazaré’s waves measure 15 to 20 meters (50 to 65 feet) tall.

But those aren’t even the biggest or most dangerous waves known. Tsunamis can cause widespread destruction when they reach shore. Then there are rogue waves: unusual, solitary waves that rise higher than all the waves around them. These can be particularly dangerous for ships that don’t see them coming. And so-called “sneaker waves” can sweep into a beach much farther inland than expected. People die every year off the U.S. Pacific coast and elsewhere as such sneakers pull them out to sea.

Big waves aren’t limited to oceans, either. Earthquakes or storms can cause seiches in an enclosed body of water, such as a lake. These waves roll back and forth like water splashing in a bathtub. Some waves we can’t even see. Internal waves can move below the surface of a waterway, for example.

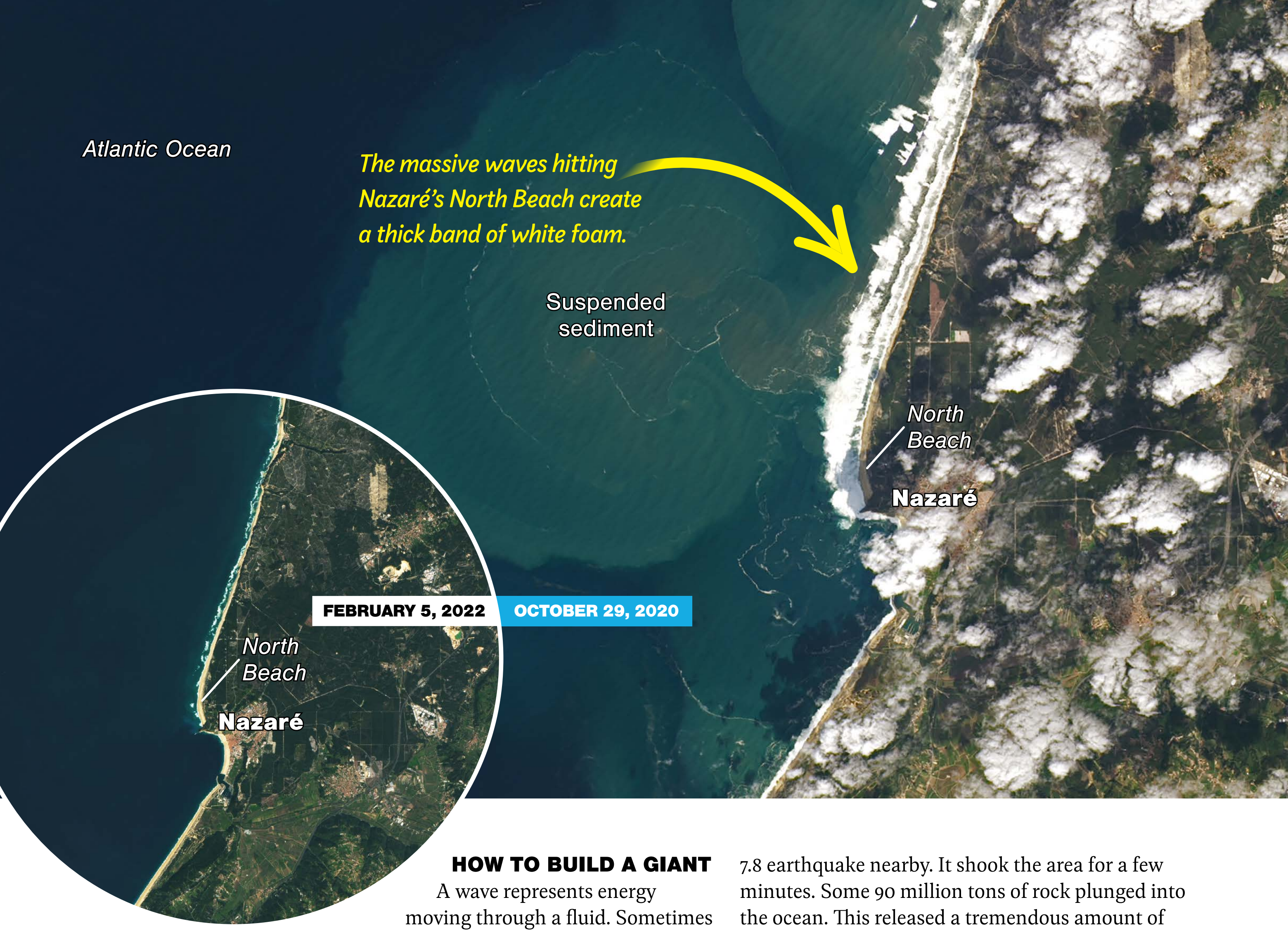
Some scientists study waves because they’re simply fascinating. But waves are important in many areas of science. Climate scientists are curious about waves that form where air and water meet. Oceanographers study them to understand how energy moves through water and to find ways to better protect coastlines. Physicists study waves to understand how moving fluids behave. Watery waves can even provide insight into the movement of light and sound.

Tori Tomiczek is an ocean engineer at the U.S. Naval Academy in Annapolis, Md. By learning what types of waves cause the most destruction after hurricanes and other big storms, she hopes to design buildings that will better survive them. But, she adds, there’s another reason to study waves. They captivate her, she says, noting “I have always just loved the ocean.”

Powerful tsunamis are rare, but some, like the 2011 Japan tsunami, can pull buildings out to sea.

On July 9, 1958, an earthquake set off rockfall into the ocean near Lituya Bay, Alaska, which created a wave 524 meters (1,720 feet) tall. Spots along the shore that appear lighter are where trees were stripped from the ground.

DON J. MILLER/USGS; PICTURA COLLECTUS/ALAMY



Waves coming into Nazaré Bay get magnified by a 210-kilometer-long (130-mile-long) canyon offshore. On a typical winter day (inset), the waves measure around 15 meters (about 50 feet) high, making this shore a popular spot for big-wave surfers. On October 29, 2020, a distant hurricane sent much larger waves toward shore and kicked up sediment from the seafloor.

NASA

HOW TO BUILD A GIANT

A wave represents energy moving through a fluid. Sometimes it's a lot of energy. The largest wave ever recorded slammed into the protected Lituya Bay in southeast Alaska in 1958. This wave reached a towering 524 meters (1,720 feet).

Scientists determined its height by observing all trees and loose soil lower than that height had vanished, leaving a new tree line. The bay itself was only about 220 meters (720 feet) deep, which means the wave was more than twice as tall. Imagine standing on the shore and seeing an approaching wall of water that was far taller than the Empire State Building.

Three fishing boats had anchored in the bay for the night on July 9. Just after 10:15 p.m., a wave about 30 meters (100 feet) high began moving into the bay. One boat tried to escape, but its two occupants were never seen again. A second boat, crewed by a man and his 7-year-old son, made it over the crest of the wave and skated down the other side. The third boat was destroyed, but the captain and his wife survived by holding on to debris.

How does a wave get so mammoth? The 1958 monster began with a powerful magnitude 7.8 earthquake nearby. It shook the area for a few minutes. Some 90 million tons of rock plunged into the ocean. This released a tremendous amount of energy and sent huge waves racing.

Earthquakes often give rise to big waves. On December 26, 2004, a magnitude 9.1 earthquake rocked Southeast Asia. The tsunami it unleashed reached 30 meters (100 feet) tall by the time it hit Indonesia. More than 200,000 people across the Indian Ocean died, making this one of the deadliest natural disasters in history.

On March 11, 2011, another magnitude 9.1 earthquake triggered a tsunami off the coast of Japan. It swept ashore, killing about 18,000 people there — and caused the meltdown of three nuclear reactors.

FROM SEASONAL TO SURPRISING

Storms, of course, can whip up big waves. So can the shape of the seafloor. Geologists have traced the big surfing waves of Nazaré, for instance, to a deep undersea canyon — one of the largest in Europe.

That narrow canyon runs east to west. It stretches from near the coast to about 210 kilometers (130 miles) offshore. As waves stream in over the canyon, they pile up higher and higher. They merge with waves coming from other directions to produce true monster waves. The October 2020 Nazaré wave got an extra energy boost from the remnants of a hurricane. By the time Steudtner took to the water, the waves were ginormous.

Weather and earthquakes can't explain every type of wave. Consider rogue waves, which were once the stuff of legends.

More than 500 years ago, Christopher Columbus reported a giant wave that nearly swamped his ship as it sailed through a strait off the coast of present-day Venezuela. And in 1826, French explorer Jules Dumont d'Urville described a huge, catastrophic wave in the Indian Ocean. At the time, almost no one believed him.

Today, oceanographers define these rogues as waves at least twice the average height of the waves around them. They can emerge without warning.

The first rogue wave ever observed by scientists, known as the Draupner Wave, hit an oil platform in the North Sea on January 1, 1995. It damaged railings and equipment. Laser sensors mounted on the platform revealed the wave reached 25.6 meters (84 feet) tall.

This wave didn't injure anyone. But that wasn't true for three rogue waves in 2010, each less than half the Draupner's height, which hit the cruise ship *Louis Majesty*. Off the French coast, a giant rogue wave pummeled the ship, tossing it around and breaking windows. Two passengers were killed.

Physicists do not agree on how rogues form. Some have investigated the idea of "crossing waves."

When lines of waves collide, they can pile up on each other, amplifying their height. Two waves with the same height can combine to form one far taller wave. This is called constructive interference. And it concentrates their energy into a single, larger wave, explains Francesco Fedele. He's an engineer at the Georgia Institute of Technology in Atlanta.

"When you have an intensification of waves, they can grow up more and more," he says.

But that's not the whole story. Waves are complicated. They are shaped both by the water and the air. When they collide, something called "second order" effects may develop. These are like side effects of side effects. And they can lead to unexpected behaviors.

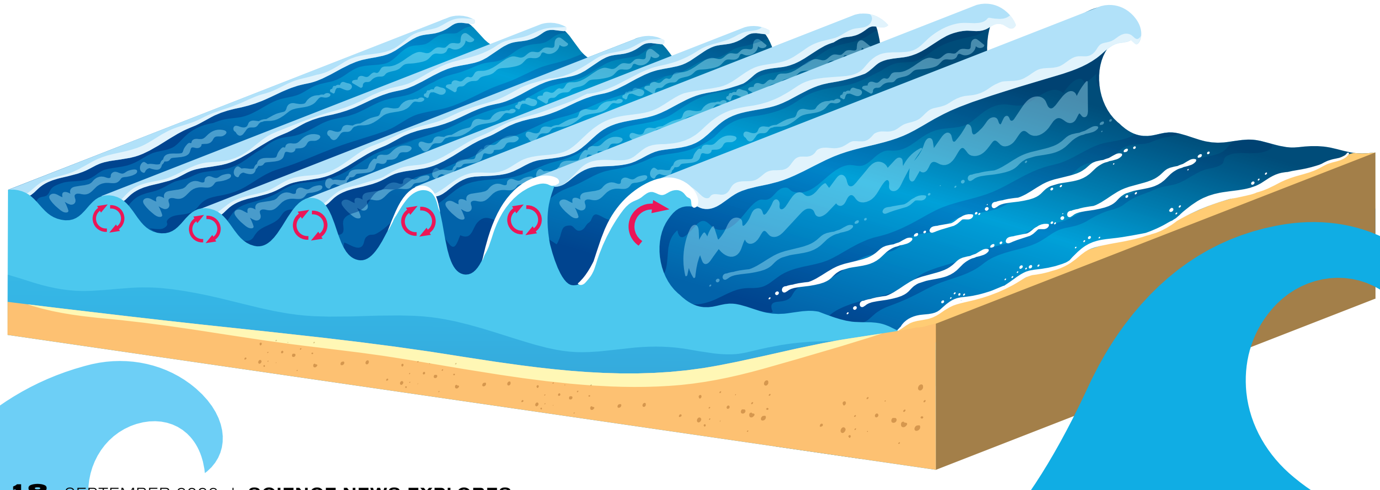
MEASURING BIG WAVES

Miguel Onorato is an oceanographer at the University of Torino in Italy. He has studied wave behaviors and rogue waves for more than two decades. In June 2018, he boarded the *S. A. Agulhas II*, a ship designed to support scientific research. It was headed from Cape Town, South Africa, to Antarctica.

This was winter in the Southern Hemisphere. Some scientists on board planned to study birds, including albatrosses and penguins. Others wanted to measure pollution in the water. An artist came along looking for

WAVE FORMATION

Wind blowing over an ocean or lake nudges the water to roll in circular motions. When those circular flows near the shore, their bottoms catch on the seafloor and slow down. The faster-moving water on top tips over and curls into a wave that crashes on the beach.



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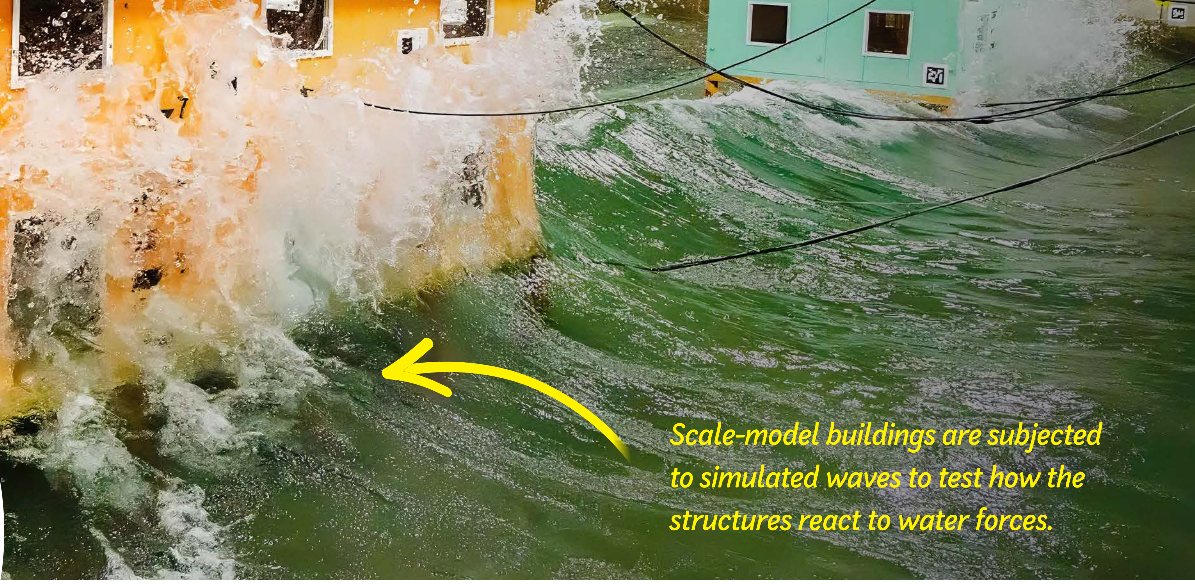


Scale-model buildings are subjected to simulated waves to test how the structures react to water forces.

Researchers at Oregon State University run a laboratory equipped with large water tanks and machines that produce waves. Here, researchers can explore how tsunamis and other waves interact with buildings, bridges and other structures.

OREGON STATE UNIVERSITY

inspiration. Onorato was part of a team that came to study waves.

Winds whip through the Southern Ocean at the highest average speeds on the planet. Storms rage all the time. They're so strong partly because of how energy travels through the ocean. The Southern Hemisphere also has few mountains to break up storm systems and winds.

Strong winds mean big waves. "The boat was rolling. I got so sick," Onorato recalls. But once he was back on his feet, his team set up its equipment on deck.

In the past, he says, scientists measured big waves with floating buoys. Their instruments can track the up and down movements of the water's surface. The rise and fall of these buoys gave a pretty good idea of the wave shapes.

But the buoys gave only one point of information. They didn't show how the waves were changing as they moved. To overcome that problem, one of Onorato's colleagues developed a new system. It uses stereoscopic vision.

The idea was inspired by human vision, Onorato says. Because the brain combines signals from two eyes, people can see in three dimensions. (It's why someone with only one functional eye will struggle with depth perception.)

Two cameras that could be trained on the same patch of sea gave the new system 3-D vision. A computer helped analyze the resulting video and determine wave heights and behaviors.

Rogue waves can form when strong winds cause steep waves to form and intersect, measurements by Onorato's team showed. These rogues can rise higher than would be predicted just by adding two waves together.

PROTECTING PEOPLE

Knowing how and when big waves form offers benefits beyond satisfying scientific curiosity. For instance, Tomiczek at the U.S. Naval Academy wants to help make coastlines safer.

She's run some of her experiments in an unusual laboratory at Oregon State University in Corvallis. Its long, narrow tank of water — a wave flume — produces big waves. Tomiczek was part of a group studying how waves damaged a house. It had been built at one-tenth scale. Learning which types of waves are the most destructive may help her design structures that will better withstand them.

For instance, the researchers were able to calculate how much force a wave exerts on a structure horizontally. This can help engineers figure out the best way to build and which materials to use. These studies could also improve other structures battered by waves, such as bridges and highways.

Such data may also help at-risk communities. If people better understand the local threat that big waves pose, they can prepare. Tomiczek says they can build stronger structures and plan how to help each other when a destructive one hits. This could build "kind of a community resilience," she says.

Her wave research had been launched by her love of the ocean. But Tomiczek also enjoys thinking about how the ocean connects people around the world. At one beach, she says, people can surf or bodysurf or enjoy the waves. Somewhere on the other side of the country or world, the waves might be too powerful for swimming.

"When I was living on the West Coast, we called [the ocean] the mighty Pacific because it's this different, untamable, incredible thing," she says. If you love the ocean, Tomiczek says, it's hard not to wonder about what makes a big wave. "It's just so cool to me to think about all of the incredible processes that are behind that."

This surfer's superpower is science

Cliff Kapono studies how coral reef structures impact wave breaks

Professional surfer and scientist Cliff Kapono gets his best ideas when he's in the ocean. "The thinking turns off, but the ideas start to pour in," he says. To him, the connection makes complete sense because the native Hawaiian word for "idea" is the same as "wave" — *nalu*.

Kapono is a native Hawaiian; these are the Indigenous people of Hawaii. He grew up in Hilo, Hawaii, where he is based today, blending his lifelong passions for surfing and science daily. "I want to understand how waves move across our planet, so I can be better at catching these waves," he says.

As a kid, he wanted to surf every day, all day long. He practiced until he could surf at a professional level. "That's the same thing that I did in science. It started off where I just wanted to take science classes and get A's; with surfing, the equivalent is catching nice waves," Kapono says.

Kapono is now a professional free surfer. These athletes chase the best swells around the world to earn sponsorships and media exposure. He also is a researcher at Arizona State University's Center for Global Discovery and Conservation Science in Hilo. He studies how humans and ocean environments interact, from molecular to macro scales, through the lens of a surfer. In this interview, he shares his experience and advice with *Science News Explores*. (This interview has been edited for content and readability.) — *Rachael Lallensack*

Q What was a research success for you?

A I'm currently trying to identify the structural complexity of reefs at some of the best, most iconic waves around the world. It's known as bathymetry, the study of the seafloor. I'm looking specifically at where certain famous waves break. Over the last five years, I've mapped the characteristics of these different reefs. I'm seeing similarities between these waves based upon their reef structure. A personal interest and curiosity is now supported by research — that keeps me excited.

Q What does surfing mean to the Native Hawaiian community?

A The clearest example of a productive society is the amount of leisure time they have. If you have a highly functioning system, you have surplus time. Our Native Hawaiian society was able to invest that time into the cultural arts, such as surfing. Surfing has been documented within our histories for close to 2,000 years. It's not just recreation. Surfing is so deeply embedded into the Hawaiian culture. It's in the stories, the chants and the songs.

Q What do you do in your spare time?

A I volunteer for a scientific group called Mega Lab that is trying to develop technology to protect the ocean and give it to communities who need it the most. One program, Map to Adapt, has a goal of mapping a million reefs by 2030. We're teaching 10,000 citizen scientists how to map reefs with their GoPro, cell phone or camera. Anyone can join.

Q Why do science and surfing fit together so well?

A Science has helped me to be a better surfer. And surfing has helped me to become a better scientist. Science is like a superpower for me. It's fun to be able to jump from a community that is so focused on riding a wave into one that wonders about how that wave moves. To me, that's a pretty epic way to live.

NANI WELCH KELI'IHO'OMALU; SARAH LEE

“Waves shape my life, and my research is a result of that,” says Cliff Kapono. “It’s not just me on a computer or with a test tube. My research includes paddling out on my surfboard and trying to catch these waves as well.”

CHEMISTRY

Cleaning up plastic pollution

Yeast binds with microplastics in easy-to-remove clumps

By Science Buddies

Tiny bits of plastic cause big pollution problems. These microplastics are almost everywhere, from the deep ocean to our drinking water. Wastewater treatment plants add chemicals that clump together with microplastics in water to remove the bits. Using microorganisms for this process instead of chemicals is called bioremediation. To give it a try, let's use yeast to trap glitter in a jar of water.

OBJECTIVE

Try out bioremediation by using yeast to remove glitter from water.

EXPERIMENTAL PROCEDURE

1. Add 3 grams (0.1 ounce) of glitter and 1 gram (0.04 ounce) of yeast to an 8 ounce glass jar.

2. Fill the jar with 200 milliliters (about 1 cup) of water. Cover securely.

3. Shake jar rapidly for two minutes, then shake slowly for five more minutes.

4. Let the jar rest for one hour. Observe the jar every 15 minutes. Note whether the glitter is floating or sinking.

5. Set up a strainer with a coffee filter over a large waterproof container.

6. Pour the contents of the jar slowly through the filter. Stop before any glitter or yeast that settled at the bottom of the jar are disturbed.

7. Carefully remove the filter and set aside to dry.

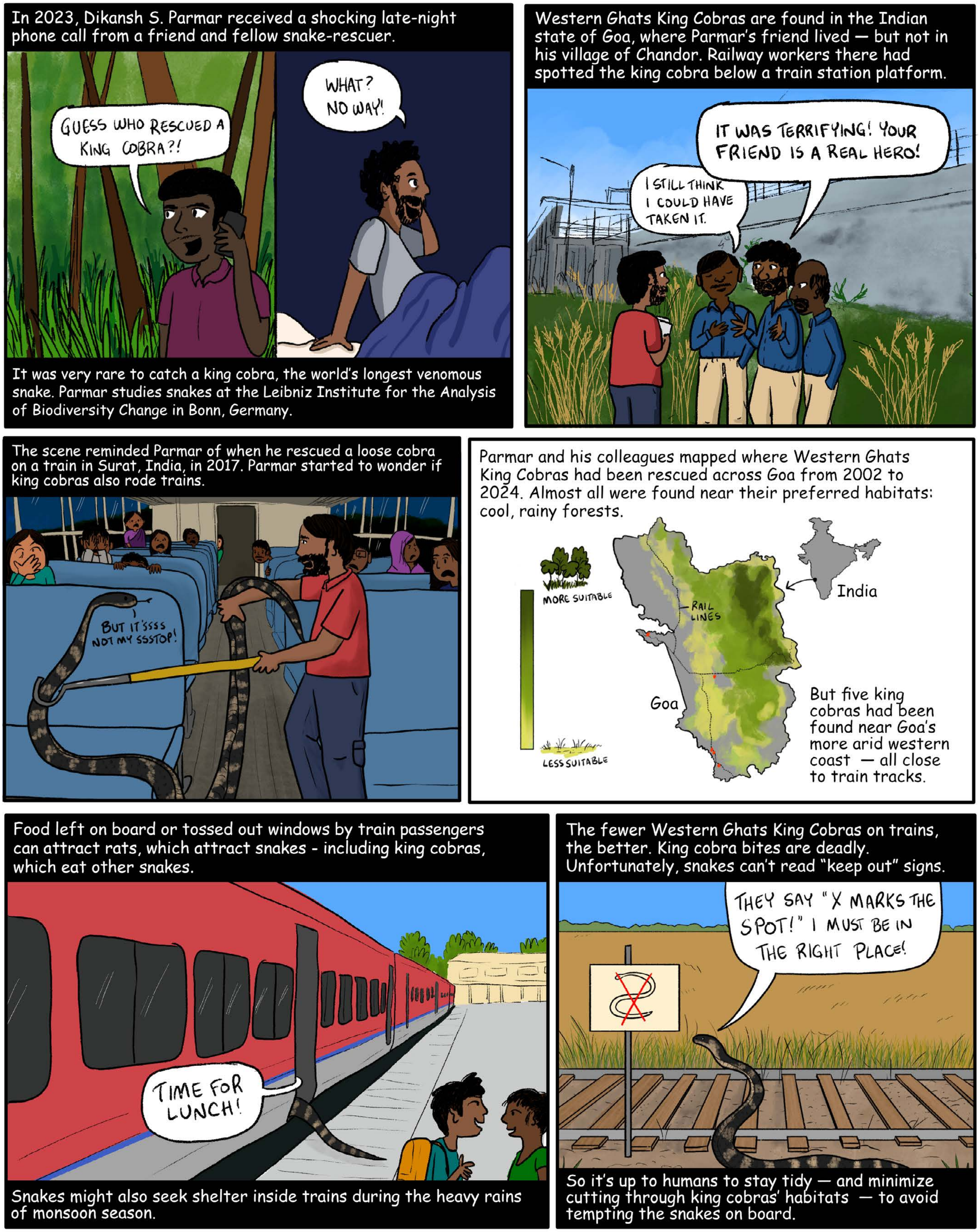
8. Zero out a scale with a fresh coffee filter. Then, weigh the used glitter filter once it is completely dried. How much glitter did the filter catch versus what settled at the bottom? What might happen if more, or less, yeast was added?

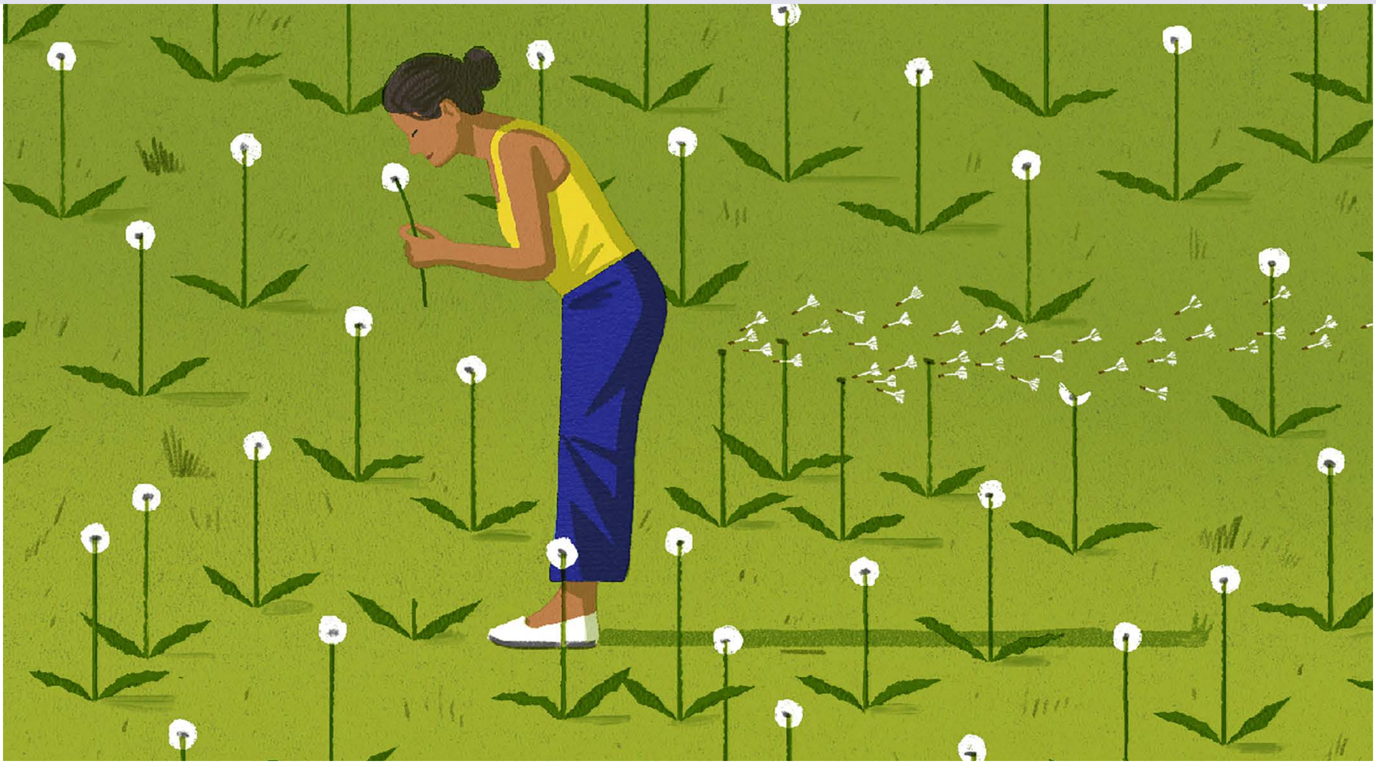
Find the full activity, including how to analyze your data, at snexplores.org/microplastics.
This activity is brought to you in partnership with Science Buddies.

SIVSTOCKSTUDIO/SHUTTERSTOCK

Snakes on a Train

Written by Maria Temming
Illustrated by JoAnna Wendel





PETE RYAN

HEALTH

Scientists get smart about farts with new underwear sensor

The quarter-sized device snaps into undies to analyze intestinal gas

Everybody farts. The question is, how often? And how much gas is too much gas to pass? Science is now starting to answer these questions. All it took was inventing a special device to fit into underpants.

Until now, no one has measured flatulence in people's daily lives.

Brantley Hall is a microbiologist and part of a team that studies the metabolism of gut microbes. Working at the University of Maryland in College Park, the group was measuring how much hydrogen gut microbes make. They used a sensor in an oxygen-free chamber. But they weren't getting results.

Frustrated, "we took the sensor out of the chamber, and we were like, 'Screw it. We're going to try to measure a fart.' " So, Hall stuck the device down his own pants and let rip. "And the signal was enormous!"

Inspired by that incident, his team devised what they're calling "smart underwear." Its sensor tracks toots, specifically the hydrogen part of farts. This hydrogen tracker is about as big as a quarter and snaps onto regular underwear.

The researchers described their innovation in *Biosensors and Bioelectronics: X*.

TOOTIN' TIME

Healthy college-age volunteers tested the device. People averaged 32 farts a day, the new sensors showed. But there was a wide range of results. Some people may toot as few as four times a day. Others passed gas as often as 59 times a day. Thirty-eight volunteers ate high-fiber gumdrops during the tests. Among them, the data show, all but two broke wind more often than they did on days when they didn't eat these gumdrops.

Hall now wants to expand the study to a much larger and more diverse group. He wants to find out whether age, diet or other things affect our gassiness.

Hall says his group was “shocked by the lack of measurements of intestinal gas.” Health workers know what’s normal for other vitals, such as heart rate, he points out. “But if you go to the doctor, they don’t know the normal number of farts,” Hall says. “If you tell them, ‘I’m farting 50 times a day,’ they don’t have really a baseline to compare that to.”

For instance, no one knows how much people fart at night. In medical settings, most studies have used rectal tubes. Other studies asked people to record their own farts — which they can’t do while asleep. “Basically, because of the limitations of measuring farts, [there is a] complete gap in our understanding,” he says. “We just genuinely don’t know. Isn’t that funny? [In] 2026, we don’t know if people are farting at night or not.”

THE HUMAN FLATUS ATLAS

In February, Hall’s team launched a project that builds on their first study. They hope it will identify a normal fart range. They’re calling this project the Human Flatus Atlas. (Flatus is a fancy word for fart.) Volunteers must wear the sensors in their underwear around the clock for three to 30 days. (That’s except for a 15-minute charge time while they shower.) They also photograph what they eat using an app on their phones.

Once they’ve located the right spot to attach the device, most people don’t even feel it, Hall says. They can wear it for almost all activities. “We’ve had people play rugby, run a 5K, do hours of volleyball practice — no problem,” Hall says. The one exception: “Biking is out. No biking.” The reason? Bike seats hit right where the sensors attach.

Findings from the pilot study suggest people tend to fall into three main categories. Remember that playground rhyme: “Beans, beans, the musical fruit, the more you eat, the more you toot?” Well for one group, it does not hold. These “zen digesters” rarely fart even after eating lots of fiber. At the other end of the spectrum are “hydrogen hyperproducers.” They fart a lot.

In between are what Hall’s group is calling “normal people” (though the researchers admit they don’t yet know the true normal range). The most and least prolific tooters in the atlas project will get 3-D-printed plaques marking their flatus status.

Like the cheese-cutting that started it all, interest in the atlas has been huge. The initial batch of 800 sensors flew out the door in just a few days. More than 3,500 people expressed interest.

Excitement for the atlas project surprised Hall. Stigma and taboos discourage discussing bodily functions. “But almost people want to talk too much to me about it,” he says. “People are very excited about measuring farts.”

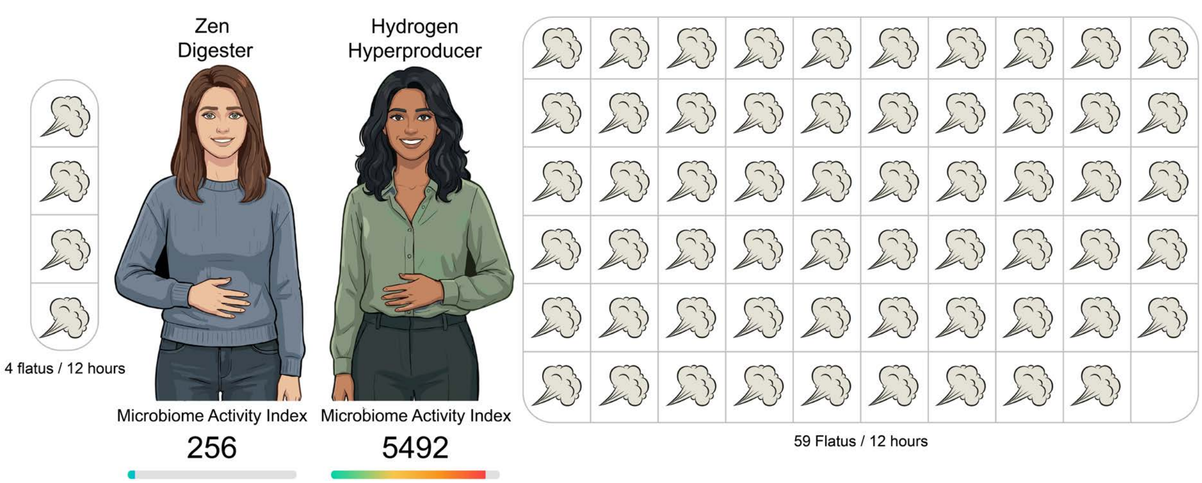
— *Tina Hesman Saey*

No cracking cheeky jokes! Being able to measure farts may offer useful health information.

When it comes to farting, what’s normal? Scientists have devised a new sensor that detects hydrogen in passed gas. The tracker is about as big as a quarter and snaps inside a user’s underwear.

WHAT’S YOUR FLATUS STATUS?

Early studies identified groups at low and high ends of a range of gas production: the zen digesters, whose farts are few and far between despite eating a high-fiber diet, and the hydrogen hyperproducers, who let it rip many dozens of times a day. Most people probably fall somewhere in between.



B. HALL/UNIV. OF MARYLAND

ANIMALS

Chatty cats and talking dogs could one day 'speak' in our language

AI advances and listening tools may someday let you talk with animals

In the animated movie *Up*, a yellow, tail-wagging dog shows up wearing an electronic collar. The main character, a curious and cheerful 8-year-old boy named Russell, tells the dog to sit. The dog sits. Russell tells the dog to shake. The dog extends a paw. Russell then tells the dog to speak.

"Hi there," says the dog.

To Russell's amazement, the dog's collar translates his doggy thoughts into actual human words. "My master made me this collar," Dug the dog tells his new acquaintances. "He is a good and smart master, and he made me this collar so I may talk — SQUIRREL!"

This is a common piece of technology in stories — a translator that can decode animals' barks, squeaks, meows, clicks and such, into human language.

Back here in the nonfiction world, anyone with a pet has probably wondered at some point what's going on in that cute little animal head. Scientists can't say. But there are reasons to think that an animal-human translator won't

ROBERT NEUBECKER

stay a work of science fiction forever. "I think these things may be one day doable," says Erich Jarvis. He's a neurogeneticist at The Rockefeller University in New York City.

One day, pets may wear little devices like Dug's collar. Or an app on a phone might translate pet sounds into words. This neat trick could finally let you learn the answer to why your cat is staring at that empty corner of the living room.

LEARNING LANGUAGES

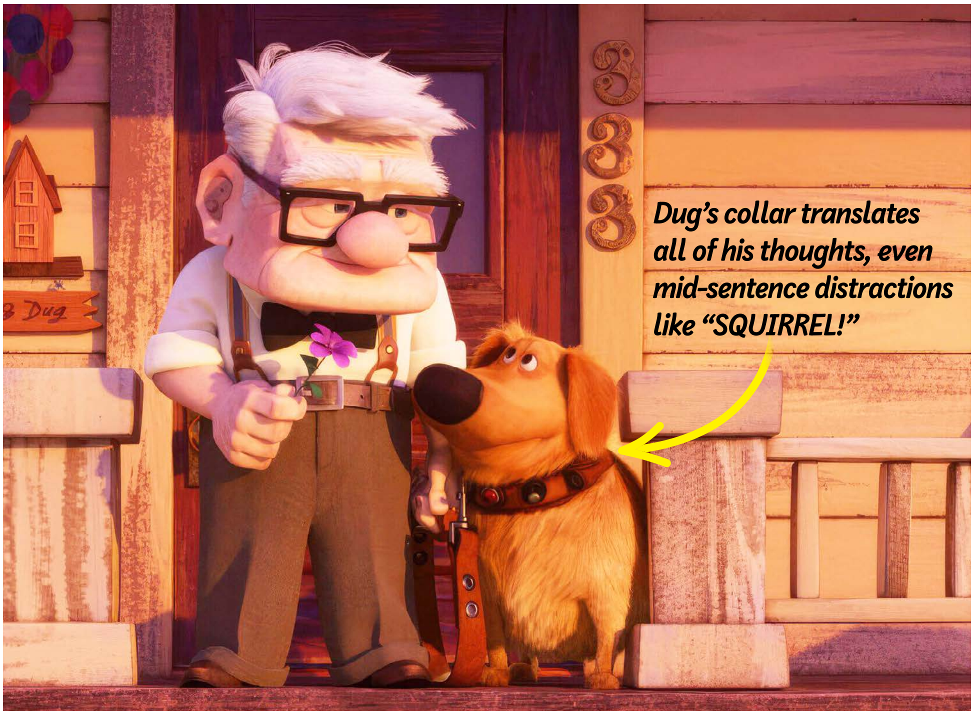
Advances in computing power, artificial intelligence (AI) and fancy tools that measure sounds promise to bring people closer to conversing with other animals. These advances could turn animal chatter into bits of information that can be decoded by humans.

Of course, some animals can already talk to us — in our preferred languages, too. Jarvis tells the story of a parrot that left its California home. It returned years later speaking Spanish, he says.

Such language skills are rare. Thinking up a message and making intricate vocal sounds to convey it take special mental skills and a great flexibility of body systems. These traits are present in fewer than 1 percent of vertebrate species, says Michael Long. He's a neuroscientist at New York University in New York City.

Not all animals may be good conversationalists. Take vervet monkeys. "Their cognitive abilities are huge," Long says. But they flounder when it comes to producing complex sounds. "So they have one of those requirements, but they need to get the other one," Long says.

And with rare exceptions, none really speak our language. But that gap can be overcome. It may just take a slight shift in what we consider talking. "Animals are speaking often — to use speaking in a very loose way — more vibrantly than we had ever given them credit for," Long says.



ALBUM/ALAMY

In the Pixar movie *Up*, a golden retriever named Dug wears a collar that translates his thoughts to speech. Such a collar doesn't currently exist. But advances in decoding animal sounds might some day make casual conversations with other creatures possible.

UNDERSTANDING ANIMALS

Like parrots, dolphins and whales may similarly make good conversation partners with people. In 2023, scientists used a decoded whale "hello" to enjoy a short conversation with an Alaskan humpback. This exchange consisted of a volley of whale whups, translated into English as "hello." Still, both parties engaged in this interspecies chat.

Another group of researchers has since discovered that whale language shares statistical properties with those spoken by humans. With these sorts of advances, perhaps we'll soon be swapping krill recipes.

Some of Jarvis' research includes mice that have been genetically changed to produce more complex sounds. He is part of a team that's closely examining key genes that are active in good vocal learners. Mice with a human version of a protein called NOVA1, for instance, made more complex vocalizations. To be clear, this is not yet a talking mouse. But the research is moving fast.

Some animal messages are clear even without a fancy sci-fi gadget. "Animals are broadly expressive," Long points out. Anguished yowls of a cat sitting by her unfilled food dish are no great mystery.

Messages don't even require a vocal tract. Mongolian gerbils, for instance, beat out messages by thumping the ground percussively. Dances, posture, color and even objects can all carry messages. Just think about it: You can probably figure out the message when a dog holds his leash in his mouth and sits by the front door.

So while we wait for a gizmo that translates our pets' thoughts into words, consider the wildly variable ways animals already communicate. Long's formerly stray Brooklyn cats, for instance, have plenty to say. Their needs and wants are "very, very transparent," he says.

Should a cat-human translator ever exist, Long's message to one of his cats would be short, sweet and practical: "I would tell him not to sit too close to the stove when I'm cooking. I think that's it."

— Laura Sanders

EARTH

Where fossil fuels come from

Spoiler alert: It's not from dinosaurs

One of the most widespread beliefs about fossil fuels — oil, natural gas and coal — is that these substances started out as dinosaurs. There's even an oil company, Sinclair, that uses an *Apatosaurus* as its icon. That dino-source story is, however, a myth. What is true: These fuels got their start long, long ago — at a time when those "terrible lizards" still walked the Earth.

Fossil fuels store energy in the bonds between the atoms that make up their molecules. Burning the fuels breaks those bonds. This releases the energy that originally came from the sun. Green plants had locked up that solar energy within their leaves using photosynthesis millions of years ago. Some plants died and decayed. Others were eaten by animals, which moved that energy up the food web.

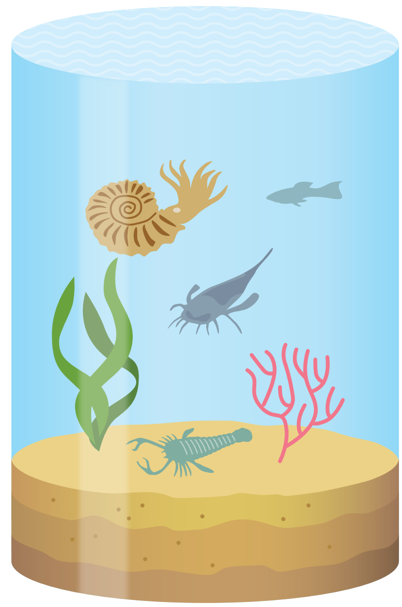
Any of these organisms, when they die, could become fossil fuels. But it takes the right conditions, including an oxygen-free (anoxic) environment — and time. A whole lot of time.

The coal we burn today got its start some 300 *million* years ago. Back then, dinosaurs roamed Earth. When plants in bogs and swamps died, they sank to the bottom of those wet areas, partially decayed and turned into *peat*. Over time, those wetlands dried out. Other materials then buried the peat. With heat, pressure and time, that peat transformed into coal.

Petroleum — oil and natural gas — comes from a process that started in ancient seas. Small organisms called plankton lived, died and sank to the bottom of those oceans. They got covered by layers of settling debris. Microbes helped break down some of the dead. Chemical reactions further transformed these buried materials. Eventually, two substances formed: waxy *kerogen* and a black tar called *bitumen* (one of the ingredients of petroleum).

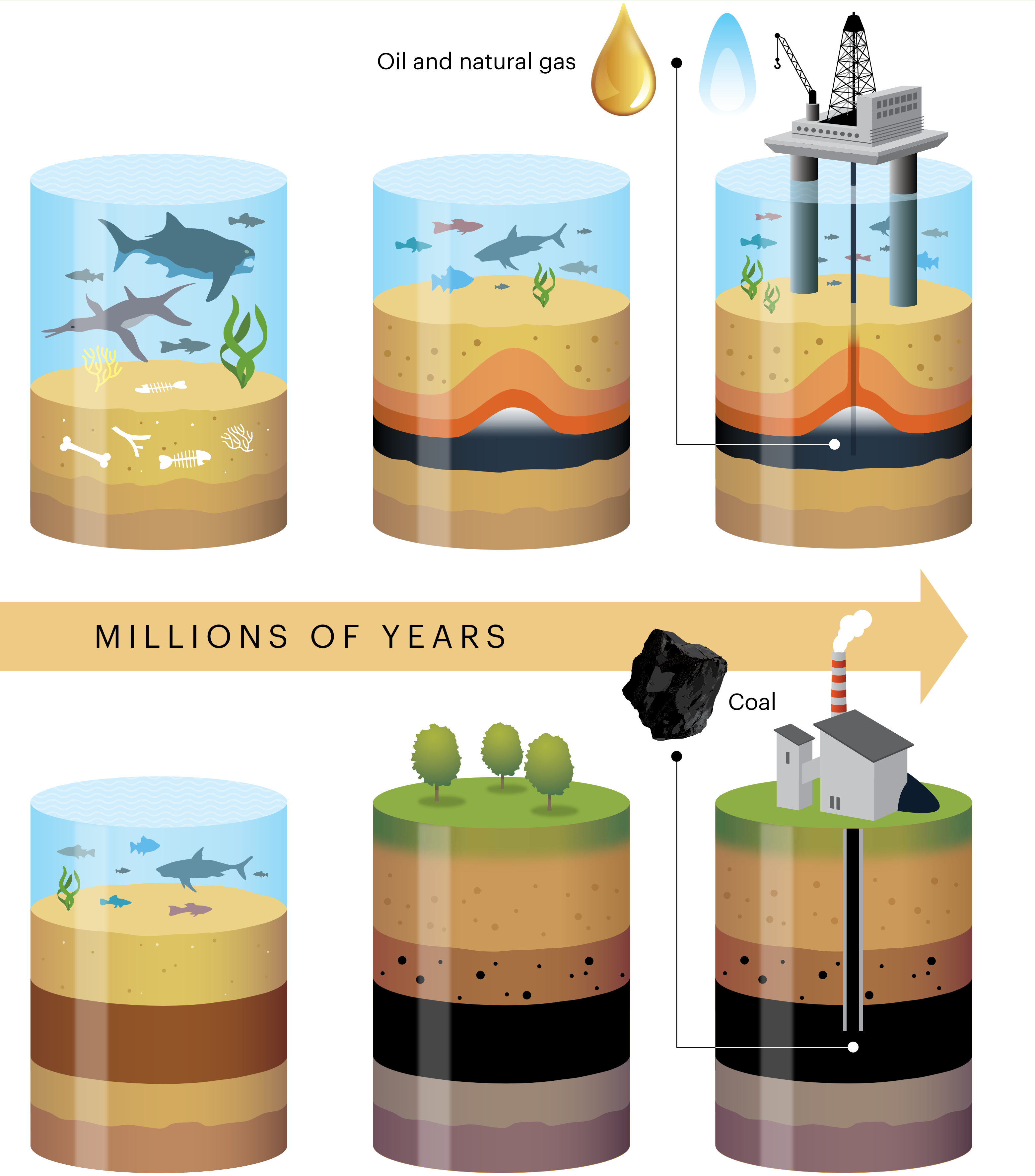
The deeper kerogen gets buried, the more heat and pressure it is subjected to. If conditions become just right, kerogen transforms into the hydrocarbons (molecules formed from hydrogen and carbon) that we know as *crude oil*. If temperatures become hotter still, kerogen becomes the even smaller hydrocarbons that we know as natural gas.

— *Sarah Zielinski*



Oil, natural gas and coal are all known as fossil fuels, but they were created in two different ways. Oil and natural gas (top) got their start millions of years ago in oceans, where remains of sea life fell to the seafloor and got buried. Over time, chemical reactions transformed those remains into hydrocarbons. That oil and gas can now be extracted through deep wells that run to the surface. Coal (bottom) comes from the breakdown of ancient plants into peat. Buried peat transformed into coal, which has to be dug out of the ground.

STEVE MCCRACKEN


Oil and natural gas
MILLIONS OF YEARS
Coal

ANIMALS

Sea slugs' secret to flashy colors

Nudibranchs make a dazzling array of hues with just one material

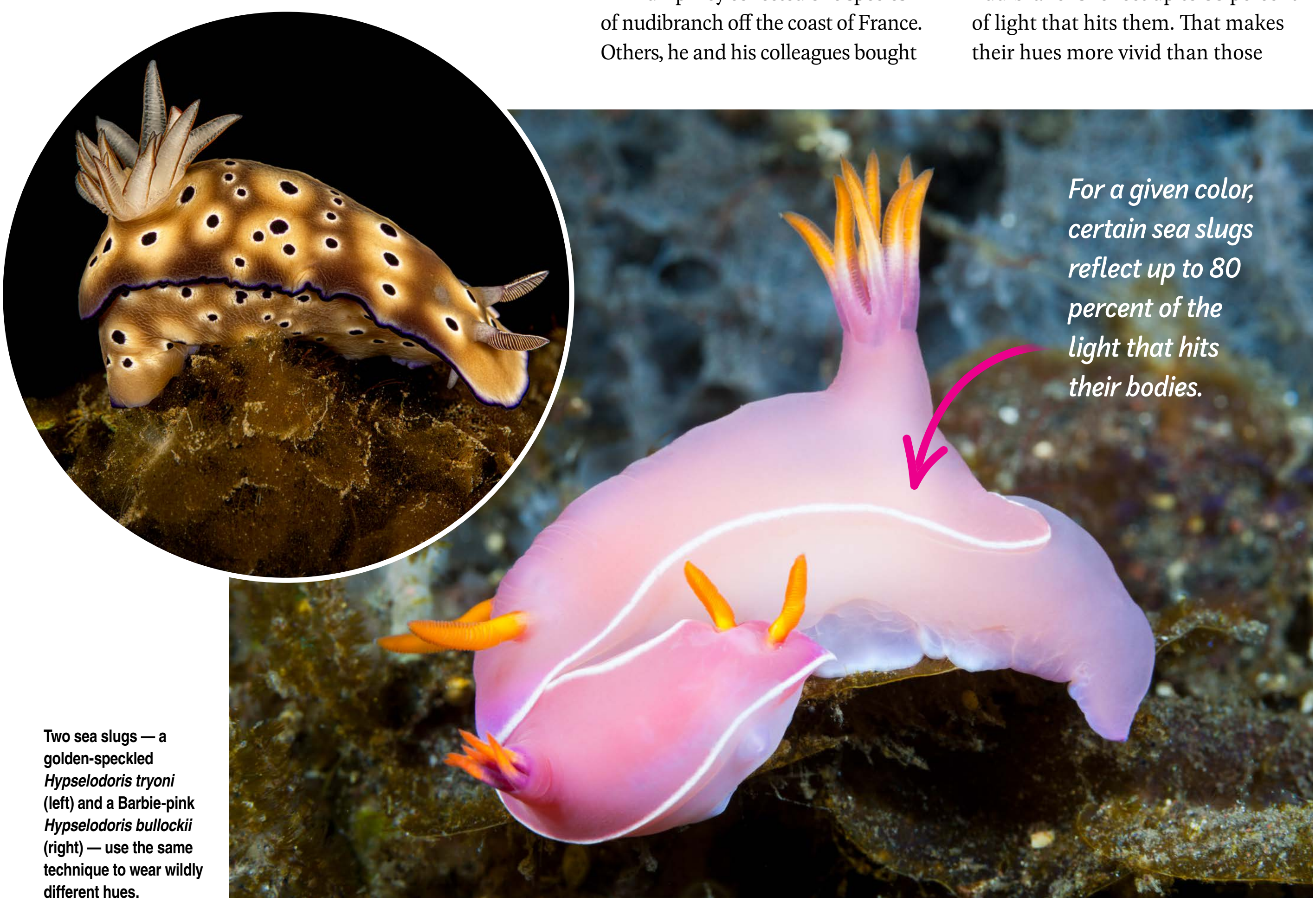
In the sea, soft-bodied sea slugs crawl around without shells to protect them. Instead, they sport dazzling colors and flashy patterns to warn would-be predators that they're toxic. Now, researchers have learned that many of these vibrant hues come from structures under the slugs' skin.

These slugs, called nudibranchs, are sometimes dubbed the "butterflies of the sea." Their colors are "exceptionally bright," says materials scientist and physicist Samuel Humphrey. He works at the Max Planck Institute of Colloids and Interfaces in Potsdam, Germany.

Not much was known about nudibranch colors, Humphrey says. But in nature, some of these colors — such as white, blue and violet — are hard to get from pigments. (Those are molecules that provide color.) That made Humphrey's team suspect the slugs' colors instead arise from light waves bouncing off structures in their bodies.

Humphrey collected one species of nudibranch off the coast of France. Others, he and his colleagues bought from aquarium shops. The researchers looked at the creatures under the microscope and saw tiny dots of colors that create a shade. A nudibranch might look violet, but zoom in, and you may find specks of red and blue. "It's a bit like mixing paints until you get the color you want," Humphrey says.

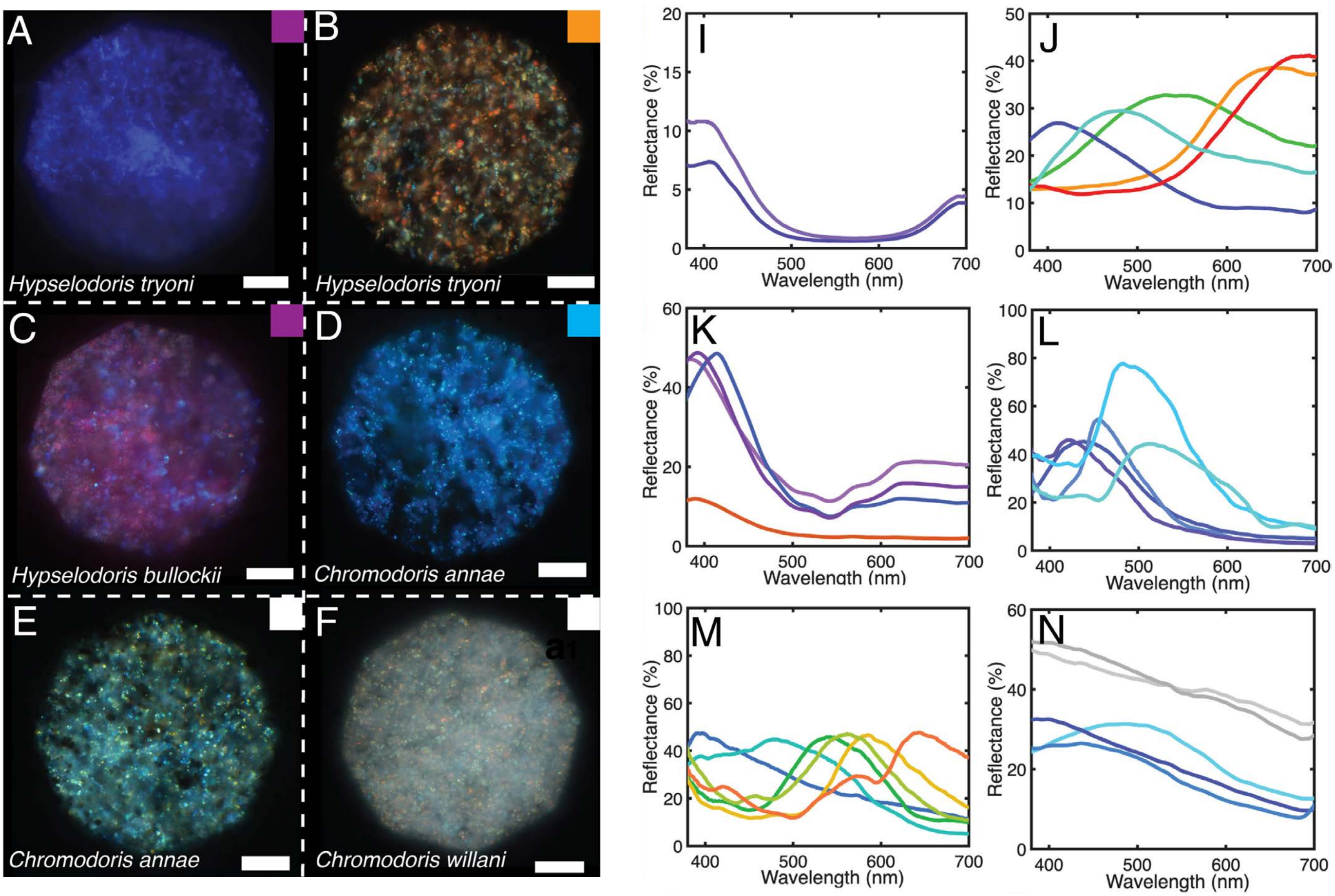
Actually, "it's better than that," Humphrey says. Sea slugs' hues arise from specific wavelengths, or colors, of light bouncing off them and reaching our eyes. For a given color, nudibranchs reflect up to 80 percent of light that hits them. That makes their hues more vivid than those



Two sea slugs — a golden-speckled *Hypselodoris tryoni* (left) and a Barbie-pink *Hypselodoris bullockii* (right) — use the same technique to wear wildly different hues.

IFISH/ISTOCK/GETTY IMAGES PLUS, REINHARD DIRSCHERL/THE IMAGE BANK/GETTY IMAGES

STYLISH SLUGS



Microscope images revealed close-ups of nudibranchs' skin (Figures A–F). These images show the many dots of different hues that make up a single area of color on the animals. Researchers also measured how these areas interact with light (Figures I–N). The graph in Figure I goes with the image in Figure A, Figure J goes with Figure B and so on. The graphs show the skin's reflectance, or how much light reflects off differently colored spots and can reach our eyes. Most colors have a specific wavelength at which the most light is reflected. For example, Figure C shows the pink region of *Hypselodoris bullockii* (shown at left), which has some violet dots. These dots reflect the most light at a wavelength around 400 nanometers (Figure K).

produced by pigments, which create colors by absorbing light.

The researchers shared their results in the *Proceedings of the National Academy of Sciences*.

With a powerful microscope, the team saw stacks of tiny plates under nudibranchs' skin. The plates were crystals made of guanine. The thickness of the plates and the distance between them in a stack determined the colors that they reflected. That allows sea slugs to wear a rainbow of colors made of just one material.

— Carolyn Wilke

HUMPHREY *ET AL*/*PNAS* 2026

DATA DIVE

1. How many types of colored light make up the violet hue of *Hypselodoris tryoni* (Figure A)?

2. How many types of colored light make up the beige or white region of the same slug (Figure B)? Which color of light has the highest reflectance?

3. Which sea slug here has the color with the highest reflectance? (Hint: Not all the y-axes are exactly the same.) What is that color and what is the peak wavelength?

4. How many different colors of light are in the region of *Chromodoris annae* shown in Figures E and M? Based on those colors, how do you think this area of the slug looks to the eye?

ANSWER

Thunderstorms can make treetops glow

Tiny electrical zaps flash across leaves and branches

In the lab, researchers showed how electrical charge and light can be shed from spruce needle tips (above). Recently, this phenomenon was also captured outdoors on a special camera during a thunderstorm.

W. BRUNE

The same forces that trigger lightning also make treetops sparkle like Christmas-tree toppers.

Just barely visible, the glow radiates faint blue with some invisible ultraviolet (UV) light. Part of a corona, the glow develops when a strong electric field breaks apart air molecules. This creates charged atoms or molecules called ions that conduct electricity.

Recently, researchers wondered if lightning might produce this phenomenon in treetops. First seen in the lab, these glows have now been spotted in nature.

To find them, Patrick McFarland and William Brune outfitted a van with instruments capable of locating thunderstorms. McFarland and Brune are meteorologists at Pennsylvania State University in State College. They also added a special camera to record the coronae's distinct UV light.

A storm in Pembroke, N.C, provided most of their sightings. Here, for about two hours, they recorded video of a sweetgum tree and a loblolly pine.

In all, they spotted almost 50 coronae. None lasted more than four seconds. The flashes jumped between leaves and along branches.

The scientists shared their findings in *Geophysical Research Letters*.

These glows seem to be really widespread, McFarland concludes. "There may be many, many more … that we just don't have the sensitivity to see."

— Lily Burton

INSIDE THE MIND OF A YOUNG SCIENTIST

A Regeneron International Science and Engineering Fair finalist answers three questions about her science

Science competitions can be fun and rewarding. But what goes on in the mind of one of these young scientists? Natalie Muro, a finalist at the 2026 Regeneron Science Talent Search and 2026 Regeneron International Science and Engineering Fair, shares her experiences.

Q What inspired your research project?
A Natalie's favorite Netflix series, *Outer Banks*, first sparked an interest in ocean science. But Natalie lived in land-locked Colorado. She wanted to use her passion for water research to help her home state. "I began to research one of the big issues we have, which is harmful algal blooms," Natalie says. She built a device that kills cyanobacteria, which cause many harmful blooms in waterways.

Q What was your favorite part of this project?
A "I really loved that I got to be able to test [my device] in a reservoir near my house," Natalie says. That local lake had been suffering a harmful algal bloom. But after exposure to Natalie's device, its water contained fewer cyanobacteria. "I loved spending the time outside," Natalie says. "I loved being able to go to the lake and actually see my device working."

Q What were your most important resources?
A "The people," Natalie says. "I have cold-emailed so many professors ... to ask if they would meet with me on Zoom so I could bounce some ideas off of them." Her mom was also a huge help, Natalie adds. "I absolutely could not have done it without her support and her encouragement."

Regeneron International Science and Engineering Fair and Regeneron Science Talent Search finalist

Natalie Muro

Natalie, 18, built a device that slowly releases hydrogen peroxide into water to kill cyanobacteria. Her device also contains a porous material called biochar to collect the dead microbes. Because hydrogen peroxide does not release any dangerous byproducts, Natalie hopes it will offer an eco-friendly way to fight harmful algal blooms. Natalie graduated from William J. Palmer High School in Colorado Springs.

Learn more about the Regeneron International Science and Engineering Fair

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