ScienceNews Explores
NOVEMBER 2025

SAVE OUR SHARKS

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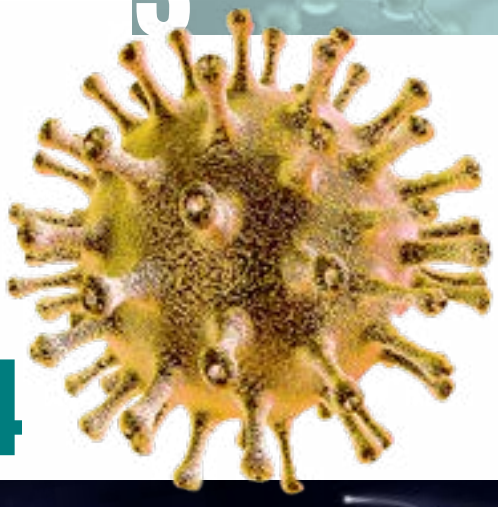
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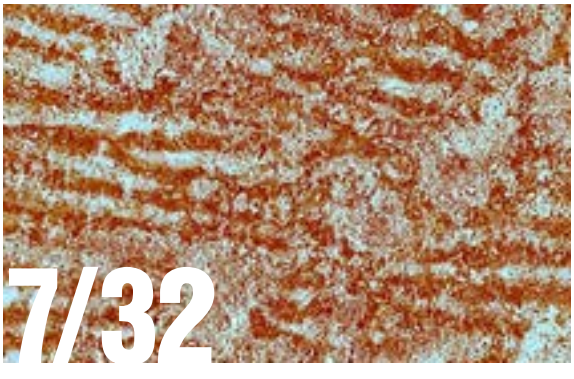
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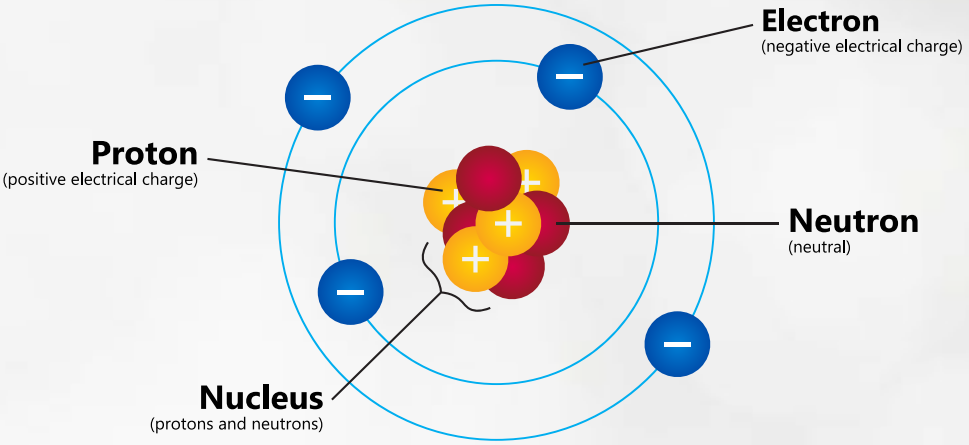
Q What is an atom made of?

— Ian K.

A Atoms are made of three kinds of particles: protons, neutrons and electrons. Both protons and neutrons can be found in the nucleus of an atom. Surrounding that nucleus is a cloud of smaller electrons. Protons have a positive charge. The number of protons in an atom's nucleus determines what element it is. Neutrons have a neutral charge. The number of neutrons in the nucleus determines what variety, or isotope, of an element the atom is. Electrons have a negative charge. The balance of electrons and protons determines an atom's overall charge. Electrons are elementary particles, meaning that they cannot be broken down into smaller particles. But protons and neutrons are made of even smaller particles called quarks. These are held together by other particles called gluons. And those are all the building blocks that make up atoms — which are in turn the building blocks for you and me!



Q What would a *T. rex* taste like?

— Joaquin D.

A Though birds are living dinosaurs, *Tyrannosaurus rex* was a non-avian dinosaur, so it probably wouldn't have tasted like poultry. The flavor profile of *T. rex* would be more complex. Most meat that we eat today is from animals that feed on plants. A meat-eater like *T. rex* would have had a much stronger, wilder flavor, perhaps more like its carnivorous crocodilian cousins. Some people who eat crocodile and alligator say they taste like chicken but with a slight seafood twist. *T. rex*, though, ate other dinosaurs, bones and all. "By the time it all mixed together and all of that stew of nutrition was converted into *T. rex* fat and muscle," says Steve Brusatte, it "probably wouldn't taste so succulent." Brusatte is a paleontologist at the University of Scotland in Edinburgh. Plus, when one animal eats another, it consumes all the parasites and bacteria its prey contains. So, not only would *T. rex* meat taste gross, it also wouldn't be very safe to eat.

Q Why do we have fingerprints?

— Lucy P.

A Fingerprints have multiple jobs. First, "fingerprints help with grip by increasing friction," says Michael Adams, a chemical engineer at the University of Birmingham in England. Emotions can prompt fingertips to sweat. This moisture softens skin at the fingertips. "The surfaces of the fingerprint ridges are quite rough, and these features flatten much more easily in the softened state," Adams says. This flattening increases the amount of contact between the fingertips and whatever they are touching, which makes it easier to grip objects. What's more, fingerprints "make your sense of touch more sensitive, especially to fine textures," Adams says. "If you slide your finger over such a textured surface, you perceive the texture by small vibrations." Fingerprint ridges are thought to make those vibrations feel stronger and clearer, Adams says.

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

BRAIN

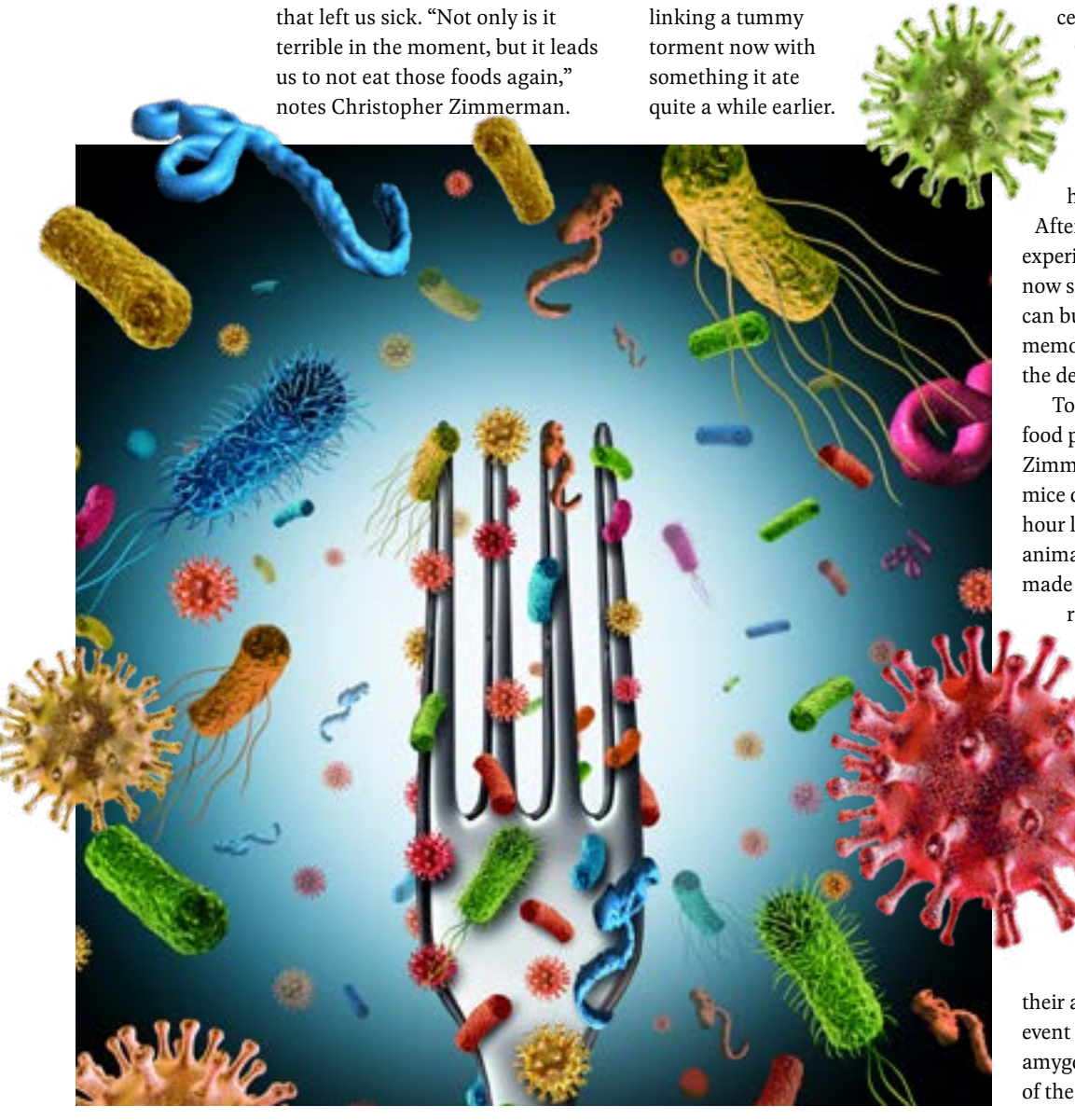
Flavor memories help the brain steer clear of food poisoning

A study of mice shows how they avoid foods that once made them sick

Food poisoning can be hard to forget. Scientists have now homed in on what makes it so unforgettable. Alarm cells lock the experience into our brain's circuitry as a yucky memory. That's the finding of a new study of mice.

Many of us have eaten something that left us sick. "Not only is it terrible in the moment, but it leads us to not eat those foods again," notes Christopher Zimmerman. He's a neuroscientist at Princeton University in New Jersey. You can still become grossed out by a food even if it takes hours or days to start feeling sick after the meal.

Many other animals, it turns out, respond the same way. Even a rodent's brain has no trouble linking a tummy torment now with something it ate quite a while earlier.



That makes food poisoning one of the best ways to study how our brains connect events that are separated in time, says Richard Palmiter. He's a neuroscientist at the University of Washington in Seattle.

A small, almond-shaped brain region called the amygdala links emotions to memories, learning and our senses. So it's not surprising that this region plays a role in deciding what flavors we find gross or not.

Palmiter's group had shown that the gut tells the brain when it's feeling icky. How? It activates certain "alarm" neurons called CGRP cells. "They respond to everything that's bad," Palmiter explains.

So researchers asked: How does the brain learn to hate foods that made us sick? After five years of planning and experiments, Zimmerman's team now shows that effects in the brain can burn dangerous tastes into memory. The researchers described the details in *Nature*.

To study how alarm neurons link food poisoning to food repulsion, Zimmerman's team at Princeton had mice drink grape Kool-Aid. A half-hour later, the scientists injected the animals with lithium chloride. This made them ill. Two days later, the researchers again gave the mice grape Kool-Aid.

The team ran versions of this simple experiment multiple times. At each step, the scientists peeked inside the brains of those mice to see what was happening. When the mice had first gotten sick after drinking grape Kool-Aid, their alarm neurons turned on. This event increased the sensitivity of amygdala cells that carried memories of the grape flavor.

LIGHTSPRING/SHUTTERSTOCK

Those same amygdala cells also turned on when the mice encountered grape Kool-Aid again. This suggests alarm neurons had helped the amygdala remember foods that seemed dangerous.

This effect didn't show up in mice that had tasted grape Kool-Aid without getting sick.

The new study's findings might go beyond food poisoning. They could be relevant to mental health.

Similar nerve pathways likely explain why unusual and bad experiences become so memorable. But this event-triggered repulsion — known as aversive learning — may sometimes go wrong in people who have suffered a trauma or who have developed some addiction.

The brain wiring that's supposed to keep us safe can now end up causing harm. Learning to control those circuits might point to new treatments.

— ELISE CUTTS

EARTH

238 kilometers
(148 miles)

That's the farthest groundwater is known to travel, spreading pollution between far-flung places

Source: C. Yang, L. Condon and R. Maxwell/*Nature Water* 2025

JACQUES DAYAN/SHUTTERSTOCK; S. ZIELINSKI

GENETICS

A single genetic 'cutout' is behind orange cats' ginger color

Multicolored cats, such as calicos and tortoiseshells, also carry this DNA deletion

Both Alani (calico cat, top) and Oscar (orange cat, bottom) likely have the same newly discovered gene mutation that leads to ginger fur in cats.

Cats come in many colors and patterns. Orange is one of the most striking. The mystery of what gene gives most ginger house cats their hue has stumped scientists for decades.

Now, two teams have just turned up the same solution: a cutout in the DNA of ginger, calico and tortoiseshell cats. The DNA deletion makes cells in cats' hair-growing structures produce a yellow-red pigment instead of the default brown-black hue. Both teams published their studies in *Current Biology*.

Researchers knew the bit of DNA, or gene, linked to ginger fur lay in a DNA bundle called the X chromosome. In cats and most other mammals, males usually have one X and one Y chromosome. Females typically have two X chromosomes.

If the ginger fur gene were on the X chromosome, then male cats with that trait would be completely orange. But in a female cat, both X chromosomes would need to carry the orange trait for her to be fully ginger. If only one X chromosome contained the trait, then her coat would likely become a patchwork of orange and black.

Indeed, that is the color pattern seen among cats. Most completely orange cats are male. Nearly all multicolored cats, meanwhile, are female.

Chris Kaelin studies genetics at Stanford University in California. He was part of a team that examined the genes of about 30 cats. They hoped to find DNA features shared only by those with orange fur. Their work revealed a deleted stretch of about 5,000 DNA base pairs near a gene called *Arhgap36*.

Hiroyuki Sasaki is a geneticist at Kyushu University in Japan. He was part of another team that identified the same deletion. Sasaki suspects the trait was passed down from one ancestral cat. That cat lived more than 900 years ago, suggest Kaelin and his teammates. They base this estimate largely on historical paintings of calicos.

— MCKENZIE PRILLAMAN

SPACE

A passing star could fling Earth out of orbit

The chance of this happening is very small — but not impossible, simulations suggest

It's pretty unlikely — but not impossible — that a drive-by star could destroy Earth or eject it from the solar system.

JOHAN SWANEPOEL/SHUTTERSTOCK

Bad news, earthlings. Computer models of the solar system's future reveal a new risk facing us all. The gravitational tug of a passing star could cause another planet to smack into Earth. Or it might fling our planet into the sun. Or it could send Earth far away from the sun, where any inhabitants would freeze.

"None of these things are probable," says Nathan Kaib with a laugh. This Iowa-based astronomer works at the Planetary Science Institute. Kaib helped make these calculations, published in *Icarus*.

Over the next 5 billion years, Earth's chance of an apocalypse caused by a passing star is only 0.2 percent. That figure is based on the number of stars passing near our solar system.

If another star gets too close to us, Mercury will be key to the risk of Earth's demise. The innermost planet's orbit around the sun is fairly oval-shaped. The gravity of Jupiter could stretch out Mercury's orbit even more — so much so that the small planet could collide with the sun or Venus. Passing stars tug on both Mercury and Jupiter, making this outcome more likely than previously thought.

In simulations, the resulting chaos sometimes causes Venus or Mars to crash into Earth. Other times, Earth crashes into the sun. Or Venus and Mars fling our world toward Jupiter. The giant planet's gravity then ejects Earth from the solar system.

The most dangerous stars are those that come closest — less than 100 times as far from the sun as Earth is. Slow-moving stars are also risky, especially ones that move less than 10 kilometers (6 miles) per second relative to the sun. That cosmic snail's pace extends how long their gravity will be able to tug on the planets.

Past encounters with other stars may have already influenced the solar system, says Renu Malhotra. A planetary scientist, she works at the University of Arizona in Tucson.

Three of the giant planets — Jupiter, Saturn and Uranus — have somewhat oval-shaped orbits. The gravity of passing stars may have tugged them onto these paths.

"It's a little scary how vulnerable we may be to planetary chaos," says Malhotra.

— *Ken Croswell*

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

MUSEUM MAKEOV

Natural history museums are revamping dioramas to be more fun and factual

BY **AMBER DANCE**

NATURAL HISTORY MUSEUMS OF LOS ANGELES COUNTY

A lot of old-fashioned (and simply old) museum dioramas are biased, boring or even unscientific. A new exhibit at the Natural History Museum of Los Angeles County offers a different approach to dioramas. This artist-created "Special Species" diorama highlights endangered and at-risk species in California with imagery inspired by Mexican folk art.

At first glance, it's a simple scene. Six adult bison and a calf mill around a stream. But if you look closer, the plot thickens.

Beside a well-worn path to the stream sits a bison skull. This herd has clearly been dropping by for some time. And it's playing a key role in the ecosystem. Scattered birds feast on bugs kicked up by the bison.

Peer into the trees on the scene's far right, and you might even spot what only one bison has noticed. Two wolves lurk, eyeing their next meal.

"Dioramas, they have such rich stories," says Matt Davis. He develops exhibits in California at the Natural History Museum of Los Angeles. That's where this bison diorama is displayed.

Imagine, Davis says, seeing this scene when the museum's first diorama hall opened in 1925. TV didn't exist yet. Full-color movies were still brand new. For many city dwellers, dioramas were the only way to see animals as they might live.

It might be like an extreme virtual-reality experience today, Davis says. "People were totally blown away."

If you've ever been to a natural history museum, you've likely seen the diorama hall. These big rooms often feature groups of animals. Some display models of people, staged in lifelike poses against painted backdrops. In fact, it might be hard to picture a museum without them.

But these exhibits have a complex and often troubling history. Diorama builders have historically gotten their materials by taking advantage of the places the animals come from. And some designers created displays that, to modern eyes, are inaccurate or offensive.

This "diorama dilemma" is forcing modern museums to reconsider how they present such scenes. Some museums have reduced or removed them. Others are playing with new diorama formats or reframing old dioramas to address misleading or racist depictions.

What this means: Diorama halls of the future might look a bit different from those you grew up with.

DIORAMAS' TROUBLED HISTORY

It's hard to pinpoint the very first dioramas. Charles Willson Peale made one of the earliest in the 1780s. Peale practiced taxidermy. That's the craft of stuffing dead animals to preserve them with a lifelike appearance.

At his own home, Peale set up a mound of earth covered with turf and trees, plus a fake pond. There, he placed taxidermied birds, snakes, a tiger and other specimens.

By the early 1900s, natural history museums started making habitat exhibits like this. These dioramas were often created by taxidermists who led hunting trips to shoot the most spectacular specimens — including endangered animals.

Hunters saw their work as one way to preserve the last of disappearing species. They also hoped these dioramas would inspire viewers to conserve the animals that remained in the wild. But they were killing endangered animals to do this.

The bison diorama at the Natural History Museum of Los Angeles County (above) may look peaceful. But a closer look rewards viewers with a complex, suspenseful tale.

ROBERT LANDAU/ALAMY

Some hunters recognized the conflict between their hunting trips and the goal of conserving species. Carl Akeley was one example. He shot mountain gorillas in what was then the Belgian Congo. The experience changed him. He persuaded the king of Belgium to set up Africa's first wildlife sanctuary. Today, it's called Virunga National Park. It's home to some 350 endangered mountain gorillas in the Democratic Republic of Congo.

Diorama-maker William Temple Hornaday also had a change of heart. He went to Montana in 1886 to collect bison for the Smithsonian Institution in Washington, D.C. On that trip, he was shocked by how fast the bison population was shrinking. So he brought live bison back to D.C., where they became the first animals in the National Zoo.

ARE DIORAMAS WORTH SAVING?

A century later, museums were starting to wonder if dioramas still had value. Many were unscientific. Plus, they had to compete with new multimedia exhibits.

In the early 2000s, some museums scrapped or cut back on dioramas. Others tried to modernize them with interactive parts and animatronics. But those choices weren't always rooted in any science on the value of dioramas.

The Oakland Museum of California took a different approach. It asked researchers to study people's reactions to dioramas. They looked at 30 studies of more than 3,800 people viewing dioramas at 17 institutions.

In 2009, their investigation came up with a strong case for dioramas. It turned out that the displays are second only to dinosaurs in getting visitors to stop and look. Dioramas didn't change how people felt about conservation. But they did reinforce concerns people already had about the environment. Some viewers felt creeped out by dead animals. But most people loved these exhibits.

Museum staff see similar responses today. "I do walk-throughs all the time of the museum, and I can hear the 'Whoooooaaaa!' " says Mariana Di Giacomo. She's a natural-history conservator at the Yale Peabody Museum in New Haven, Conn.

The Field Museum in Chicago, Ill., recently got public support to finish a diorama started more than a century ago. Akeley had mounted four striped hyenas shot in 1896. But they never got the full scenic treatment. In 2015, the museum launched a social-media campaign to finish the project. In just six weeks, some 1,500 donors raised more than $150,000.

Gretchen Baker led planning for the museum's exhibits at the time. "It showed us that there is an enduring interest in these dioramas," she says.

Artist and explorer Belmore Browne paints a glacier for a diorama of mountain goats at the American Museum of Natural History in New York City in 1946 (top). Striped hyenas collected in the late 1800s recently got the full diorama treatment at the Field Museum in Chicago, Ill. (bottom, left). They were shot by hunter-taxidermist Carl Akeley, who poses in Somalia in 1896 with a leopard he killed (bottom, right).

AMERICAN MUSEUM OF NATURAL HISTORY; JOHN WEINSTEIN, C.E. AKELEY/©FIELD MUSEUM OF NATURAL HISTORY

BATTLING BIASES

Dioramas' eye-catching nature gives them great storytelling potential. Unfortunately, the stories many tell are not entirely scientific.

"A lot of people have called them, in the past, 'bad science' because they personify animals," says Marjorie Schwarzer. She wrote the book *Riches, Rivals and Radicals: A History of Museums in the United States.*

Many dioramas show animal groups that include a mom, dad and babies. But many species don't live that way. Papa bear does not stick around to help raise the cubs. Indeed, Schwarzer says, "Papa bear might eat a couple of the cubbies."

Some exhibits misrepresent female animals, too, Baker notes. She now directs the Carnegie Museum of Natural History in Pittsburgh, Pa.

Females are often the ones who lead animal groups in the wild. But Baker observes that they don't usually take charge in dioramas. Likewise, homosexuality exists in nature but rarely shows up in dioramas.

In many cases, designers likely wanted to show the different forms of the animals, says Mark Alvey. He works at Chicago's Field Museum. Mom-dad-baby groups offer an easy way to show adult males, adult females and young animals all at once.

"We always knew it was wrong," Davis says. "Now, we're slowly trying to fix some of those things."

THE HUMAN ELEMENT

There also are problems in how people are — or aren't — depicted in dioramas.

Some ignore humans completely. This erases the long-term presence of Indigenous peoples in many places. It also ignores the impacts of modern societies on the environment, even though very little of the world is untouched by humans.

"The kind of nature that dioramas exhibit, it's very unnatural," says Martha Marandino. A professor of biology education, she works at the University of São Paulo in Brazil.

New York's American Museum of Natural History recently dealt with problems in its "Old New York" display. Made in 1939, it shows a fictitious 1660 meeting between a Dutch leader and high-ranking members of the Lenape Tribe. The Lenape people were the original residents of the land that would become Manhattan.

Stereotypes riddle the display. Only Lenape men are in on the discussion. And they wear loincloths. That's not how they would have dressed for a diplomatic meeting. Plus, only the Dutch leader, Peter Stuyvesant, was named in the original display.

In 2018, curators added labels to explain problems with this display. They also added the name of the Lenape leader Oratamin.

Sometimes, this type of reframing isn't enough to fix a diorama's problems.

Take "Lion Attacking a Dromedary." (A dromedary is a type of camel.) This display, created in 1867, showed a dark-skinned man on camelback under attack by lions. One lion was male, even though it's generally females who hunt. Worse, the man was dressed in a mishmash of clothes that represented no specific culture. To top it all off, the man's head held a real human skull.

The whole display had been created by known grave robbers.

Some museums have updated exhibits to be more scientifically accurate and better highlight modern societies. The lion diorama at the Natural History Museum of Los Angeles (top) has evolved over the years to include more female lions and reflect more natural behaviors, such as lounging and nuzzling. The Cal Academy of Sciences commissioned artist Walter Kitundu to create an exhibit (bottom) that illustrates a storefront from the market in Dar es Salaam, Tanzania, where he grew up.

PAUL BRIDEN/ALAMY; CALIFORNIA ACADEMY OF SCIENCES

"It's not educating anyone on anything that ever existed," points out Aja Lans. She's an archaeologist at Johns Hopkins University in Baltimore, Md. Andrew Carnegie bought the diorama in 1899 for his museum in Pittsburgh. In recent years, staff have tried putting up warning signs, so people could avoid the diorama. They also added labels to point out its problems.

Then, in 2020, a white police officer murdered a Black man, George Floyd, and sparked a nationwide conversation about racism.

"This diorama was kind of like a poster child for all of these questions that were coming up," Baker says. "It was kind of this symbol of a time in natural history museums when we would display the other — the exotic — the colonized." That summer, the museum covered the display.

In 2023, the museum chose to no longer display human remains at all. So it shut down this diorama for good. It's now being taken apart. Lans and colleagues are analyzing bits of teeth from the skull to pin down its origins. The museum hopes to return it to the country where the man grew up.

The "Reframing Dioramas" exhibit at the Natural History Museum of Los Angeles County illustrates how dioramas came to be. The "Special Species" display includes colorful sculptures of at-risk species, such as the San Clemente Island snail (upper right) and the North American beaver (bottom).

NATURAL HISTORY MUSEUMS OF LOS ANGELES COUNTY

DIORAMAS FOR A NEW AGE

Back in Los Angeles, upstairs from the bison is a revamped diorama hall. It shows some drastically different scenes.

One, called "Special Species," pulses with changing lighting and bright colors. It's home to piñata-style sculptures of at-risk California critters such as the Chinook salmon and the desert tortoise. The sculptures are in the style of fantastical Mexican creatures called alebrijes. (You might have seen some animals like these in the film *Coco*.)

Artist Jason Chang, who goes by RFX1, was on the team that created the diorama. He hopes viewers will walk away with "an urgency to protect the environment."

"Special Species" is just one part of the exhibit "Reframing Dioramas: The Art of Preserving Wilderness." This project highlights dioramas' historical importance while adding modern science.

In one new diorama, video projections show how the Los Angeles River has changed over the centuries. Another shows an eerie scene in which wildebeest sip from a polluted stream amid metal-plated plants.

Still other displays show how traditional dioramas came to be. One features a hunting camp-style tent. That exhibit calls out the power imbalances at work when rich, white hunters traveled to extract specimens. Today, that display notes, most large specimens that the museum mounts died of natural causes at zoos or wildlife centers.

For all their problems, wildlife dioramas still bring striking nature scenes to people who might never see them in the wild. They also retain their power to inspire wonder and a love of nature.

The science and art of dioramas will continue to evolve. Davis hopes the L.A. museum's new exhibit lights the way.

"We don't think this will be the last word on dioramas," he says. "We hope it's the first word."

SAVE OU SHARKS

Humans have driven sharks to the brink of extinction, but it's not too late to turn the tide

BY **BRIANNA RANDALL**

You're more likely to be struck by lightning than bitten by a shark. Millions of people swim in the seas each year. But an average of just 64 bites are recorded annually worldwide. Only about six of those are fatal. That's according to the International Shark Attack File.

People often fear great white sharks due to their size, many sharp teeth and predatory nature, but humans are a far bigger threat to sharks than they are to us.

SHANE MYERS PHOTOGRAPHY/SHUTTERSTOCK

Still, many people fear and mistrust sharks. In truth, rather than worrying about sharks hurting us, we instead should fear for them. Sharks are vital to maintaining the oceans' health and resilience. Yet since the 1970s, populations of the world's sharks and their close cousins, rays, have dropped by more than 70 percent. Scientists reported this in 2021. Today, one-third of shark and ray species are threatened with extinction.

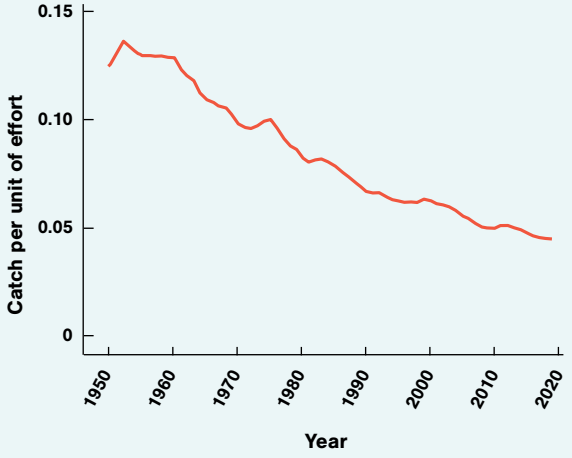
Climate change, pollution and habitat destruction all take a toll on sharks. But their biggest peril is humans. Overfishing has driven the decline of more than 90 percent of the 1,266 species assessed by the International Union for Conservation of Nature (IUCN).

"Generally, people think that sharks are monsters — cold, unfeeling — and we don't really have much compassion for them," says Grant Smith. He's managing director of Sharklife, a research and education group in South Africa. "That just leaves them wide open to exploitation and harm."

To save sharks, Smith and others believe we need to flip the script: Think of sharks as awe-inspiring wildlife instead of food or foes. This requires teaching people about why sharks are more valuable alive than dead.

A GLOBAL DECLINE IN SHARKS

The relative abundance of sharks and rays worldwide, as measured by fishing data, has dropped since the 1950s. This graph shows that decline by dividing the total weight of fish caught by the amount of effort it took to catch them.



N.K. DULVY *ET AL*/*SCIENCE* 2024, ADAPTED BY B. PRICE

ANIMALS AT RISK

Sharks have survived on Earth for at least 400 million years. But their biology makes them especially vulnerable to threats like overfishing. Why? They grow slowly and don't reproduce until later in life. The Greenland shark, the world's longest-lived vertebrate, lives up to 400 years. Females, however, don't breed until they are 150. Great whites can live to be 70, and females aren't ready to have babies until they are about 15 years old.

This slow life cycle means sharks "can't keep pace with how fast we're removing them from the environment or how fast their habitat is changing," explains Jodie Rummer. A fish physiologist, she works at James Cook University in Townsville, Australia.

Overall, we know very little about most shark species. That's especially true for those that dwell in the deep. This lack of knowledge makes it challenging to protect them. Luckily, that's starting to change as scientists learn more about sharks.

Researchers are discovering about one new shark or ray species each month, says Rachel Graham. She's the executive director of the conservation group MarAlliance. Hundreds of species of sharks, skates and rays have been identified just since 2001.

Nurse sharks suction food like crabs and shellfish from the ocean floor. They are nocturnal and often sleep in caves or crevices during the day.

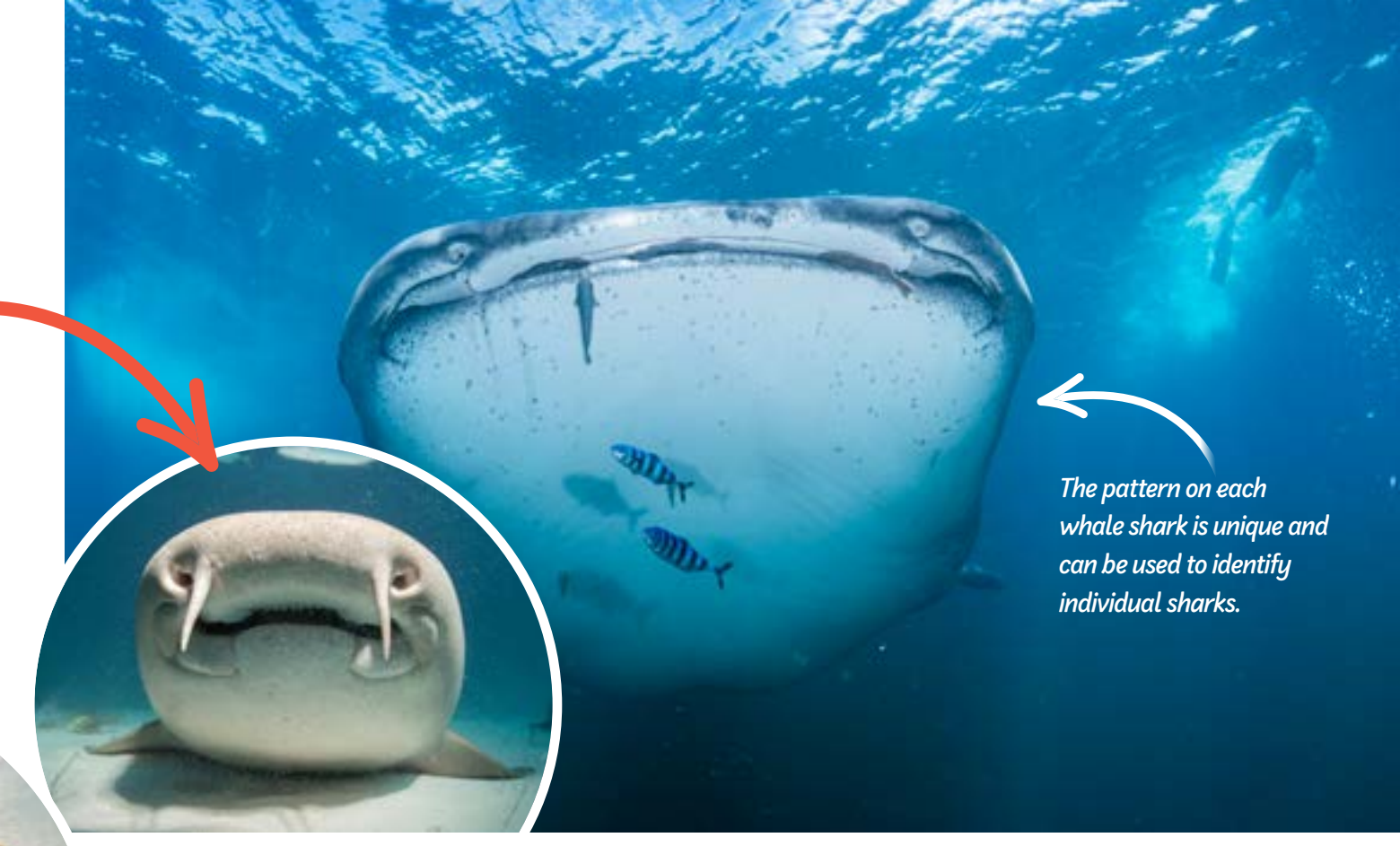
This hammerhead shark became tangled in a net meant to collect other seafood. This is a major threat to sharks. Animals accidentally caught this way are known as "bycatch."

TOBY MATTHEWS/OCEAN IMAGE BANK

FISHING SHARKS TO EXTINCTION

Rima Jabado is visiting a rural village on the coast of Oman in the Middle East. At the port, men are unloading hundreds of dead sharks from their boats. The shark scientist smiles at the skeptical fishermen. This is often how she begins her fieldwork. She's out to catalog the hauled-in species and interview the fishermen.

Jabado chairs IUCN's Shark Specialist Group. Across Africa and Asia, she and her colleagues identify and measure dead sharks and rays. They collect genetic samples, too. "Not a lot of people are interested in spending days with dead sharks at a fish market," says Jabado. But it's an effective, if grisly, way to figure out what is (or was) in different parts of the ocean.



The pattern on each whale shark is unique and can be used to identify individual sharks.

MAUI TOPICAL IMAGES/SHUTTERSTOCK; SHANE GROSS

Endangered whale sharks are the largest fish in the ocean and feed on plankton and small fish. These sharks are very gentle and will swim calmly beside human divers.

For instance, from 2010 to 2012, Jabado and her colleagues collected data at a bustling fish market in Dubai. That's in the United Arab Emirates, another Middle Eastern country. Sharks there are auctioned daily for sale in international markets. More than 12,000 sharks were identified from more than 30 different species. Many of them were destined for Asia, Jabado's team reported in 2015 in *Biological Conservation*.

Talking with fishers and fish sellers also reveals how people use sharks and rays, Jabado says. In Mauritania, in West Africa, people catch many sharks each day but don't eat them. Instead, they ship the meat to other countries in Africa. Skins of critically endangered rays wallpaper elevators in luxury hotels in Monaco, in Europe. And around the world, shark liver oil is widely used in makeup and skincare products.

A 2024 IUCN report, led by Jabado, compiled data from 353 scientists in 158 countries to show where sharks are caught and where they are shipped. Indonesia, India and Spain account for about one in every three sharks killed worldwide. The United States and Mexico round out the top five shark-fishing countries. The European Union imports nearly one-fourth of all shark and ray meat globally.

Only about one-quarter of sharks are caught intentionally. The rest are what's known as bycatch.

Sharks have survived on Earth for at least 400 MILLION YEARS.

They fall prey to the many nets, hooks and traps that had targeted tuna, cod, shrimp and other seafood.

Sadly, the demand for shark and ray meat has nearly doubled since 2005. More people are turning to these fish as a protein source as overfishing has cut supplies of other seafood. And many rural communities depend on sharks for food and income. This creates pressure to overfish.

Shark fishing can be sustainable. But to do that, the animals must be responsibly harvested. And quotas must be set and enforced by authorities. In the United States, 85 percent of the volume of sharks caught are spiny dogfish. These sharks are certified as a sustainable seafood source by the Marine Stewardship Council. Commercial harvests of spiny dogfish are carefully monitored and regulated. This abundant shark, roughly a meter (yard) long, is mainly exported to the European Union for fish and chips.

ANOTHER KIND OF FISHING

One balmy April weekend off the coast of Key West, Fla., dozens of excited anglers head out in boats. Each team's goal: hook as many bull sharks as possible in two days to win the Spanish Fly Shark Tournament.

Catch-and-release tournaments like this one are popular in some countries, including the United States. At these events, recreational sport fishers hope to land a shark for the thrill of it. Between 2005 and 2015, more than 66 million sharks were hauled in by recreational anglers along the U.S. Atlantic coast alone.

Most sport-fishing rules require releasing the animal after it's been landed, photographed and measured. But many sharks are injured or die in the process. When they are pulled up from the water, their internal organs can be crushed and their vertebrae damaged.

A global review of catch-and-release research found that roughly one in every seven sharks, on average, will die post-release. Some species, though, are more sensitive to fishing than others, such as hammerhead or blacktip reef sharks. That's according to a 2023 review of the data in *Conservation Physiology*.

"Catch-and-release is still harm," says Smith. Many people frown upon this type of sport for charismatic land animals like lions, he argues. "Would you be allowed to exhaust an animal and then suffocate it for a while, starve it of oxygen, take a few pictures, everybody says, 'Good' — and then let it free?" He hopes we can "close the public empathy gap" and treat sharks with respect and compassion.

The movie Jaws was a 1975 blockbuster. Its portrayal of sharks as bloodthirsty man-eaters bred widespread mistrust and fear of these animals.

LINA TRUMAN/SHUTTERSTOCK; BFA/UNIVERSAL PICTURES/ALAMY

TURNING FEAR INTO FASCINATION

A dozen children play on a sandy spit at a century-old family fishing camp on Isla Partida, off Mexico's Baja California. Their fathers and uncles sit in the shade mending fishing nets. These men are the fourth generation to make a living by chasing fish — including sharks — from dawn to dusk. Most hope these children will not follow in the men's footsteps.

WHAT IS A SHARK?
FIND OUT ON PAGE 28

LAURENT BALLESTA

Paloma Aniló Calderón León, 15, wears a T-shirt with a hammerhead shark. It's the logo of a local conservation group, Pelagios Kakunjá. Paloma wants to be a marine biologist when she grows up. Her mother, Ana León, and father, Malaeel Salgado Calderón, are all for it. "There are very few fish left today," Calderón says. It takes more and more time and fuel to find sharks, he says. So there is little profit from fishing.

Now, Calderón hopes to get paid to study sharks instead of kill them.

His family is part of a project led by Pelagios Kakunjá to train 30 fishers in Baja California as field technicians. Each will drive a boat to find sharks. Then they will collect blood and tissue samples. They also will drop cameras to collect videos and place sensors underwater to track temperature and water chemistry.

In 2012, Mexico banned shark fishing from May through July. This protects vulnerable species during their breeding season. Sharks have started to come back.

Last year, researchers captured and tagged a juvenile hammerhead for the first time in Cabo Pulmo National Park. That's a marine protected area near the southern tip of Baja California.

Other Baja fishers are joining the growing ecotourism industry. The region is a world-class destination for swimming with or watching mako, blue, thresher and white sharks. Shark-related tourism generates more than $300 million a year globally. That number is expected to double in the next 20 years, according to the IUCN.

A scientist measures a great hammerhead shark with a laser plate in French Polynesia. Shark fishing was banned here in 2006, helping to preserve the area's sharks and rays.

A SUCCESS STORY

Two scientists scuba dive in the teal water off the island of Rangiroa in French Polynesia. They are searching here, in the middle of the South Pacific, for great hammerhead sharks. When they spot one, they film the animal for identification. A laser plate measures its body at 4 meters (13 feet) long. Next, they deploy a spear gun to place a tracking tag on the shark. It also collects tissue for analysis. It's a little like giving a human a shot with a needle. The shark swims away unharmed.

The three-year Tamataroa Project is supported by the groups L'Œil d'Andromède and Gombessa Expeditions. Its data will help reveal why endangered great hammerheads gather off this island from December through April. It will track what they eat and from where they're migrating.

The population of these sharks has declined by an estimated four-fifths globally over the last 70 years. Luckily, Rangiroa still has large groups of these sharks. The area also boasts abundant gray and blacktip reef sharks. Manta rays, stingrays and spotted eagle rays thrive here, too.

There's at least one clear reason why: A law banned shark fishing in 2006.

Polynesians' willingness to protect sharks stems in part from the "grand cultural link" between people and sharks, says Tatiana Boube. She's a shark ecologist at the University of French Polynesia in Tahiti. "In Polynesian culture, mankind is at the same level as any other life." For some Polynesian families, sharks are a totem animal.

French Polynesia's success shows that the people who live closest to these animals need to be on board with keeping them alive, Boube says. It also gives hope that sharks will return in force to Baja and other coastal regions where local people are changing fishing practices.

Once people are invested in conserving sharks, they are more willing to create and uphold rules that help keep sharks alive, says Graham of MarAlliance.

The most positive sign that the currents might be shifting in sharks' favor, Graham says, is a change in attitude and behavior. She points to reactions from people in Belize in Central America as an example. "Instead of 'Oh my god, I'm so scared. ... They need to kill the shark.' It's 'Oh my goodness, we got to see a great hammerhead! It was huge. Everybody was so excited,'" Graham says.

Her grand vision is that everyone sees a shark every time they swim in the ocean. For that dream to come true, Graham says, "we need a shark hero in every community."

READ MORE

The New Sharks and Ocean Life Encyclopedia

By Claudia Martin

Ready to be a shark hero? Learn more about the wide variety of sharks that swim the oceans and their vital impact on ocean health with this book.

LINDEN TREE BOOKS

A shark encounter inspired this researcher to pursue a career in marine biology

Freelance shark scientist Heidy Martinez works to study and protect these misunderstood fish

Heidy Martinez never dreamt of studying sharks. That changed during a study abroad trip in South Africa in college. She went cage diving with some classmates. That's when divers view sharks underwater while inside a protective cage. Martinez was mostly there for the thrill.

The boat ride was proving to be a bummer. Martinez's wetsuit didn't fit. And everyone was feeling seasick. When she entered the ocean, a woman beside her said she felt ill. "All of a sudden, she pukes," Martinez recalls. "Then a wave comes, so all that puke just lands on me."

At that moment, a white shark approached the cage. To see the shark, Martinez immediately dived, puke and all. But the sight was worth it, she says. Movies usually show these sharks as bloody predators. But this white shark looked entirely different. "I was shocked at how beautiful the shark was," she says. "Seeing that white shark was a pivotal moment in my career."

Today, Martinez is a freelance shark researcher. She works with different organizations to study how these fish live and explore ways to protect them. In this interview, she shares her experiences with *Science News Explores*. (This interview has been edited for content and readability.) — *Aaron Tremper*

Q What was it like to change your career path?

A My degrees are in anthropology and psychology. It felt really scary when I decided to switch careers in my mid-20s. I was afraid that my parents would think everything I'd done so far was a waste of time. My family left Colombia when I was 6 so that I could have a better future. But my dad actually got teary-eyed when I told them about my career change. He explained that he had wanted to study marine biology, too. It felt like this full-circle moment. My dad left everything behind so I could do what I love. And that job ended up being what he always wanted to do.

Q What does your work as a freelance scientist look like?

A It offers me amazing opportunities to work with different species of sharks. Working with different organizations allows me to really improve my skills. It's also made me more adaptable. I'm constantly working with new people on different boats.

My life can feel really exhausting. My backpack is my home. I've been doing this for the past five years or so. It's unstable, but it's also worth the sacrifice.

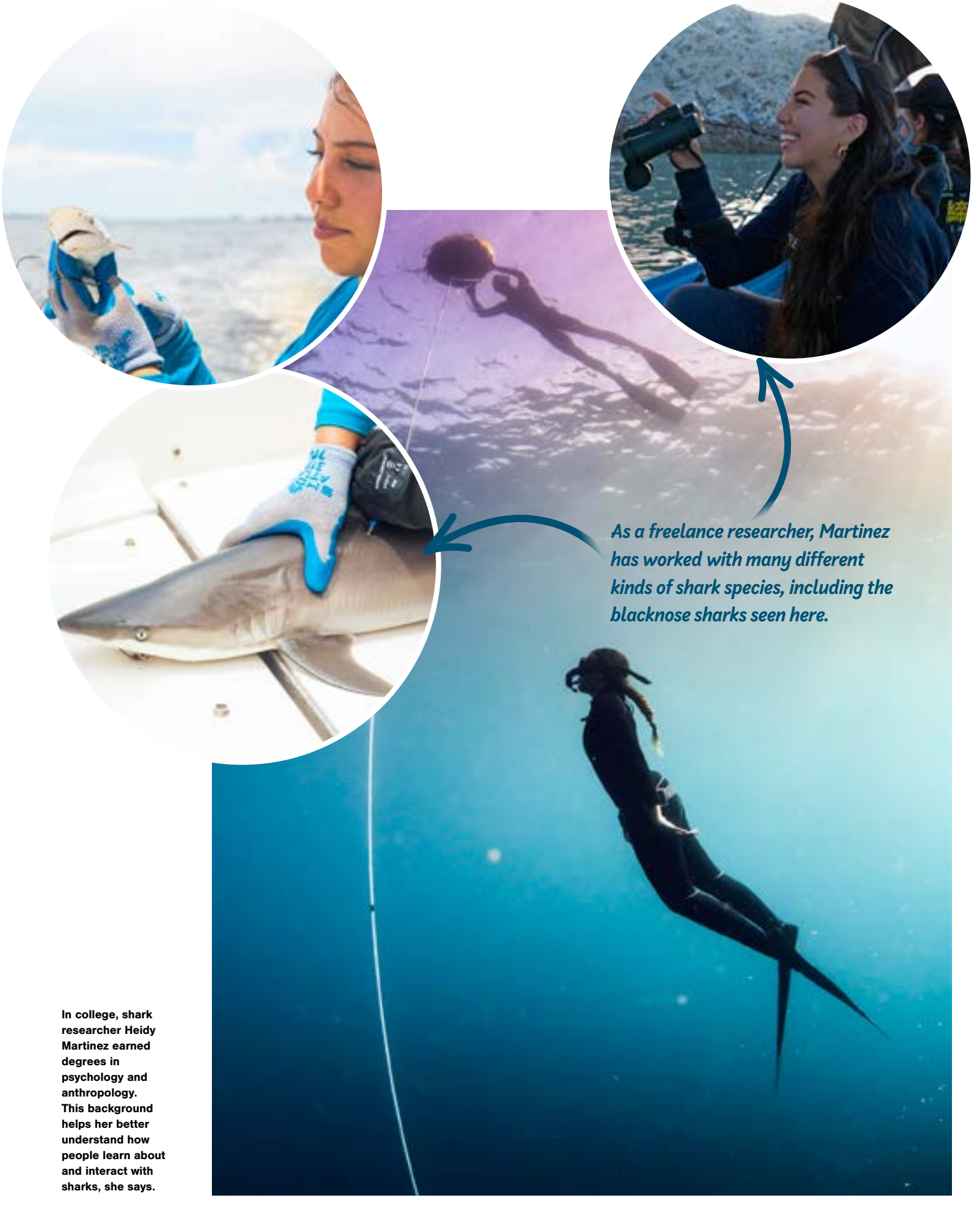
Q How do you feel your background has helped your career?

A Just because I don't have a marine biology degree doesn't mean I don't know how to do the work. My friends remind me that graduate school will always be there. These job opportunities won't. I am, though, hoping to get my master's in the next couple of years.

My degrees have shaped me into the scientist and conservationist I am today. Anthropology allows me to consider cultural differences. And my psychology degree helps with understanding how people receive and interpret information.

For example, clam divers in the Gulf of Mexico have lost their lives to shark encounters. Of course, their reaction is to hate sharks. A lot of scientists will try to lecture the fishermen about how sharks don't regularly attack clam divers. But studying psychology taught me that if you want people to listen to you, you have to listen to them first.

MADDY GETTY PHOTOGRAPHY & MISS; VICTOR MANUEL TAMANEGI AND SSCS; SAM HENRY/FATHOM FREEDIVE



As a freelance researcher, Martinez has worked with many different kinds of shark species, including the blacknose sharks seen here.

In college, shark researcher Heidy Martinez earned degrees in psychology and anthropology. This background helps her better understand how people learn about and interact with sharks, she says.

CHEMISTRY

Reveal the hidden colors in autumn leaves

Let's uncover pigments that lurk beneath the green

By Science Buddies

Have you ever wondered why tree leaves change colors in autumn? During summer, leaves use green pigment to harvest energy from the sun. But as winter approaches, many trees stop using green pigment this way — letting other pigments lurking in their leaves become visible. Let's uncover those hidden colors.

OBJECTIVE

Separate the pigments in tree leaves

EXPERIMENTAL PROCEDURE

1. Put 10 grams of shredded green, yellow and red leaves in three different jars.

2. Add 4 teaspoons of isopropyl alcohol to each jar. Mash up the leaves.

3. Put the jars somewhere dark indoors for 30 minutes.

4. Pour the leaf solution from each jar into a plastic bag. Through a small opening, squeeze the liquid into a heat-resistant container. Rinse and dry the jars.

5. Put the heat-resistant containers in a pot of hot water on the stove until the alcohol has mostly evaporated.

6. Cut a paper towel into inch-wide strips as tall as the jars.

7. Use a toothpick to paint a bit of each leaf solution onto its own paper towel strip, one inch from the bottom.

8. After the strips dry, apply another layer of leaf solution to each. Repeat at least five times.

9. Repeat Steps 7 and 8 twice, for three paper towel strips total per leaf solution.

10. Pour enough isopropyl alcohol into each jar to cover the bottom.

11. Tape each paper towel strip to a pencil. Lay each pencil across the top of the jar for its leaf solution. The bottom of each paper towel strip should just touch the alcohol.

12. Let alcohol spread up each strip until it almost touches the top. Take the strips out to dry.

13. What colors do you see on the strips for each leaf color?

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

SCIENCE BUDDIES

Pigments called xanthophylls paint fall leaves bright yellow. Carotenoids give leaves their orange hues. And anthocyanins turn autumn leaves sharp red.

VARUNA/SHUTTERSTOCK

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

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

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

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AMYGDALA
APOCALYPSE
BLACK HOLE
CARTILAGE
CHROMOSOME
DENTICLES
DEUTERIUM
DIMPLE
DIORAMA
ECOSYSTEM
ELECTRON
ELECTRORECEPTION
EXHIBIT
FINGERPRINT
GENE
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MEGALODON
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NEANDERTAL
OVERFISHING
PAREIDOLIA
PICKLEBALL
PIGMENT
PREDATOR
SHARK
SIMULATION
SOLAR SYSTEM
SPECIES
TELESCOPE
TRANSISTOR

PATPITCHAYA/SHUTTERSTOCK

TECHNOLOGY

Dynamically dimpled 'skin' may reduce drag on vehicles

Golf balls, pickleballs and sharks inspired the new surface

The dimples on this sphere can be made deeper or shallower. Their depth affects drag. Here, Anchal Sareen watches the sphere as it hangs in a wind tunnel for testing.

J. LITTLE

When Anchal Sareen saw some pickleballs lying around a lab a few years ago, her thoughts went to submarines and airplanes. She bought a balloon and wrapped it around the pickleball. It became the inspiration for a new surface her team is developing to speed and steer aircraft and underwater drones.

The surface has dimples, like a golf ball. But those dimples are adjustable. Add air and they smooth out. Remove air and the dimples deepen.

In a pair of recent papers published in *Flow* and *Physics of Fluids*, Sareen and her colleagues at the University of Michigan in Ann Arbor have now shown how dimple depth can alter drag. This is the friction-like force that slows things traveling through a fluid. The researchers showed that changing some — but not all — of the dimples can even help steer an object through air, water or other fluids.

"That's a cool idea," says Christopher Douglas. Drag is a big challenge, so "anything you can do to minimize drag is great." Douglas is a mechanical engineer at Duke University in Durham, N.C., who did not work on the new skin.

The shortfin mako shark is the fastest shark in the world. When it makes sharp turns, toothlike scales called denticles on its skin can bristle or lay flat. These changes may help it move faster.

WHEN SOME DRAG IS GOOD

Engineers, Douglas notes, have long been altering the roughness of surfaces to reduce drag. But drag can be useful, too. Fins and rudders, for instance, guide a ship by increasing drag in one place more than in another.

For inspiration, Sareen has looked to animals. Some swimmers, she says, change the texture of their skin to manipulate the flow of water around them. One of her favorites is the shortfin mako shark. "The fastest sharks in the world," she says of them — "they're like the cheetahs of the ocean." This fish can swim around 50 kilometers (30 miles) per hour.

Engineers suspect its skin is the secret to this shark's speed. It's covered with tiny toothlike scales called denticles that can change quickly. When the shark is cruising, these will lie almost flat against its body, reducing drag by about 10 percent. When the shark takes sharp turns or bends its body to navigate, the denticles move — but only on some parts of its body, Sareen says.

"They actually bristle, which means they lift up," she explains. Denticles can lift out by as much as 50 degrees. That changes the flow of water around them — and the skin's drag.

STEERING WITH DIMPLES

Sareen had long been interested in applying that idea to new vehicles: somehow changing their surface to help direct their movement. And that's where the balloon-covered pickleball comes in.

She showed one to a student interested in how dimples affect the flight of golf balls. He and other researchers then used 3-D printing to create spheres with different-sized dimples. On these models, which looked like giant golf balls, the dimples had fixed sizes.

By hanging these plastic models in wind tunnels, the team could identify how dimple depth affected drag.

Next, they printed hard spheres with holes. These looked like pickleballs. They jacketed the holey spheres with a stretchy material. Then they attached these covered spheres to a vacuum pump, which could remove air. Wind-tunnel experiments showed that changing dimple depth by about 0.1 millimeter (0.004 inch) could reduce drag over a ball by 50 percent.

Dimples can also can produce lift. That's a force that can raise a vehicle and change its direction.

By changing the arrangement of dimples, Sareen's team could not only control drag but also the trajectory of the ball's travel. That prompted them to investigate how dimples might be used as a sort of steering wheel for solid objects that separate a fluid as they move through, leaving a wake behind.

"We are improving on that design as we speak," she says. The team is also developing tests to see if the design would work in real-world conditions, such as for the skin of some vessel sailing through air or water.

This is a critical next step. "There are many different ways to control a system," says Douglas. A wind tunnel is a controlled environment, he notes. In the open air or water, the effects of a dimpled skin may be more difficult to predict.

"A lot of people have asked me, 'Are you planning to patent this as a golf ball which can stay in the air?'" Sareen laughs and says: Not any time soon.

— *Stephen Ornes*

A pickleball (above with paddle) wrapped in a balloon inspired a new adjustable surface that could one day reduce drag on airplanes, autonomous underwater vehicles (above, left) and more.

DAVID VAUGHAN/SCIENCE SOURCE; WESTEND61 GMBH/ALAMY; GLEN EDWARDS YYC/SHUTTERSTOCK

PHYSICS

Could tech ever shrink us?

Trying to downsize like Ant-Man or the Magic School Bus might create a black hole

When Alice from *Alice in Wonderland* consumes a mysterious bottle labeled "drink me," she quickly shrinks to the floor. The Magic School Bus once shrunk down to explore a sick person's bloodstream. And Ant-Man is famous for using his shrinking technology in Marvel films and comics.

But will humans ever be able to shrink down like this in real life?

Unfortunately, no. Tech with the power to make someone bite-sized would break the laws of physics. Still, scientists have fun pondering how a fictional shrinking machine might work.

"It drives you to think about: What does determine the size of things?" says physicist James Kakalios. Finding the answer can involve looking into the hearts of atoms and stars like the sun.

SMUSHING ATOMS TOGETHER

One way to shrink something would be to reduce the size of its atoms. All normal matter is made of atoms. Each one is made up of electrons that surround a nucleus.

An atom's size depends on several fundamental constants, including the charge of an electron. Tweaking those constants would require breaking the laws of physics, says Kakalios. He works at the University of Minnesota in Minneapolis and wrote the book *The Physics of Superheroes*.

If shrinking atoms wouldn't work, what about shortening the space between them?

Atoms come together to build all kinds of molecules. In the first *Ant-Man* movie, Dr. Hank Pym explains that he made his famous Pym Particles by learning how to reduce the distance between atoms. This, he claims, is what gives Ant-Man's suit the power to contract down to the size of an ant — or even smaller.

Atoms and molecules in the human body, though, are already packed closely together. Trying to get them even closer would require immense amounts of pressure. That would be bad news for any person who tried it on themselves. "The technical term is 'gross,'" Kakalios says. "It would just smush you, and you don't want to do that."

PHOTO 12/ARCHIVES DU 7E ART/ALAMY

In the movies, Ant-Man rides a tiny "steed" named Ant-thony. But in real life, the weight of a shrunken superhero would crush any insect he tried to ride!

DARK GEL/SHUTTERSTOCK; CINEMATIC/CINEMATIC COLLECTION/ALAMY

EXPLOSIONS AND BLACK HOLES

Atoms do get pushed together in our solar system, notes Salvatore Rappoccio. He's a physicist at the University at Buffalo in New York. To see this in action, just look to our sun. Like all stars, it is powered by fusion. That's when atomic nuclei are brought together under immense pressure until they form a new atom.

Fusion releases enough energy to make our sun shine. Scientists are trying to recreate this process on Earth to generate power. But it wouldn't be very useful for shrinking. "You would explode," Rappoccio says.

Venturing farther into the universe offers extreme examples of what happens when matter is packed very closely together. Black holes form when mass gets packed so densely that nothing can escape its gravity.

Black holes are typically born when massive stars explode and their cores collapse. A black hole has never been created on Earth. But Rappoccio says that in theory, any object — even a person — could become a black hole if it were compressed into a small enough space.

If you somehow became that dense, you'd perish long before you could tell the tale. Creating a shrink ray to squeeze other objects down to an extreme density could also be devastating. In *Despicable Me*, Gru tried to shrink the moon to steal it. In real life, if you try to shrink the moon, "it would become a black hole and destroy everything," Rappoccio says.

FANTASTICAL AND REAL SHRINKING

Even if Alice, Ms. Frizzle or Ant-Man were somehow able to bypass the laws of physics to survive shrinkage, they would face other problems.

Shrinking a person's vocal cords would give them a very high-pitched, quiet voice. And if their mass stayed the same, they would be incredibly heavy for their size. Ant-Man would crush any ant he tried to ride! Puny people might not even be able to see very well. As their eyes shrunk, their ability to process visible wavelengths of light might become worse.

"None of this is possible," Kakalios says. But it's well worth thinking about. "It's given me an excuse to talk about real physics."

Kakalios also notes that the science of making things smaller is not entirely imaginary. Although tech may not be able to shrink people, humans are remarkably adept at shrinking our tech.

Take transistors. These devices act as building blocks for your computer, phone and other devices. There can be billions of transistors in a device. Each one used to be the size of a person's fingernail, Kakalios notes. Now, they can be built even smaller than viruses.

This feat of downsizing has given us world-changing modern technologies. And it's all thanks to the same physics that keeps shrinking technology for people from existing. "By figuring out the rules by how the world works," Kakalios says, "we can then use these rules to make our lives better."

— *Alex Viveros*

ANIMALS

What is a shark?

These fish have skeletons made of cartilage, not bone — and aren't nearly as scary as portrayed in the media

Picture a shark. You might think of the iconic great white. Or maybe a hammerhead, with its distinctive T-shaped noggin. Or the jumbo-sized, extinct megalodon. But that's just a tiny sample of the splendid diversity of sharks swimming Earth's waters.

There are more than 500 living species of sharks, notes Heidy Martinez. She's a freelance shark scientist and member of Minorities in Shark Sciences. Sharks range in size from the gentle giant whale shark — which can reach up to 18.8 meters (61.7 feet) long — to the dwarf lantern shark, which is tiny enough to cradle in the palm of your hand. Most sharks are only about a meter (three to four feet) long or less.

Sharks belong to a class of fish called Chondrichthyes. This group also includes skates, rays, chimaeras and sawfish. Fish in this class have skeletons made not of bone but of cartilage. This cartilage, similar to the stuff that your ear is made of, is more flexible than bone. It is also less dense, which, when combined with an oil-filled liver, helps to keep these animals afloat.

Other defining characteristics of sharks include the number of gills, body shape and keen senses.

If you were to pet a shark, "it feels like sandpaper," says Martinez. That's because shark skin is covered with denticles. Denticles are tiny, overlapping scales. As a shark swims forward, these scales flatten and reduce drag, helping the shark swim with less energy. Denticles also help prevent barnacles from attaching to a shark.

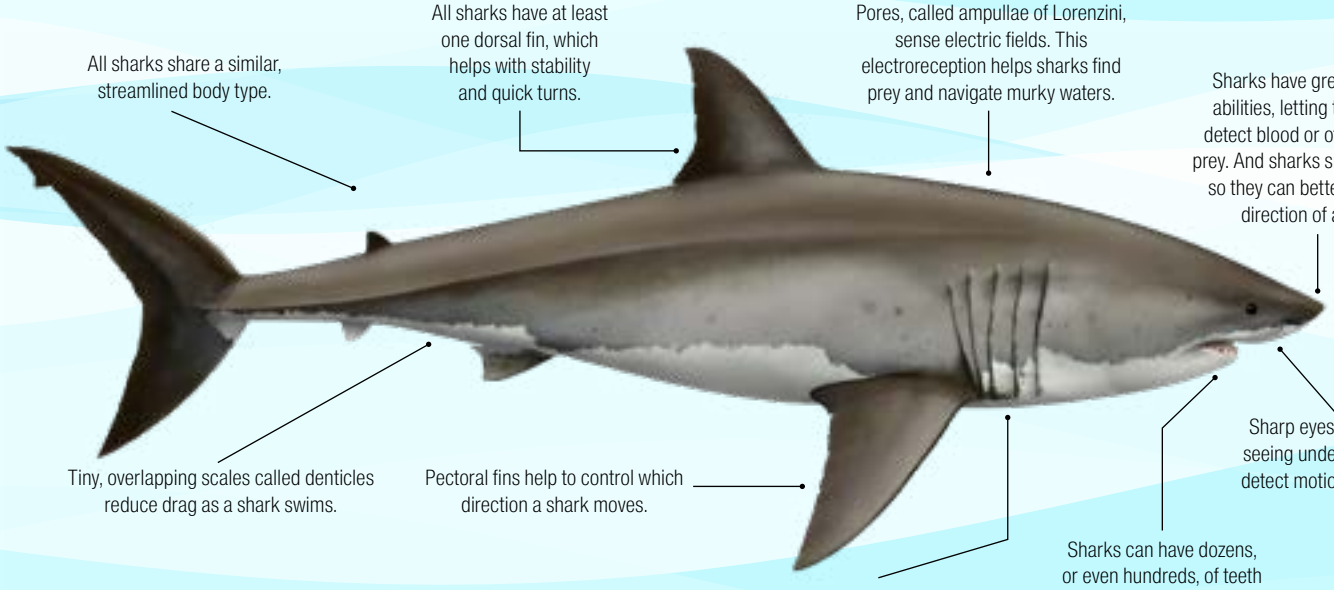
One of Martinez's favorites is the cookie cutter shark. This roughly foot-long shark takes round, cookie-shaped bites out of large fish like tuna, marlin and even other sharks. "They're so tiny and they look so different from ... what you would think," she says. Another shark she likes is the tiger shark, which will eat pretty much anything and can turn its stomach inside out to get rid of the inedible bits.

Fear of sharks can make it difficult for people to care about them. But, Martinez says, "they are not out to hurt us." Humans should show sharks the same respect.

— *Sarah Zielinski*

There are more than 500 living species of sharks. "They're all so different from each other," says Heidy Martinez.

Great white shark



JBOY, GONZALO JARA/SHUTTERSTOCK

Cookie cutter shark

Cookie cutter sharks get their name from the cookie-shaped bites they take out of other fish.

Caribbean reef shark

These large, apex predators are one of the few species of shark that don't swim while they sleep.

Lemon shark

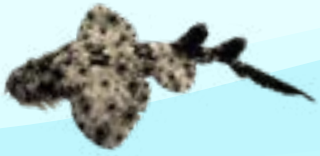
Young lemon sharks prefer to hang out with their friends.

Leopard shark

Leopard sharks get their name from the distinct pattern on their skin and sometimes form schools with other sharks, such as spiny dogfish.

Great hammerhead shark

With eyes on either end of their T-shaped head, hammerhead sharks have great binocular vision. They can increase their view further by rotating those eyes and sweeping their heads side to side.



Wobbegong shark

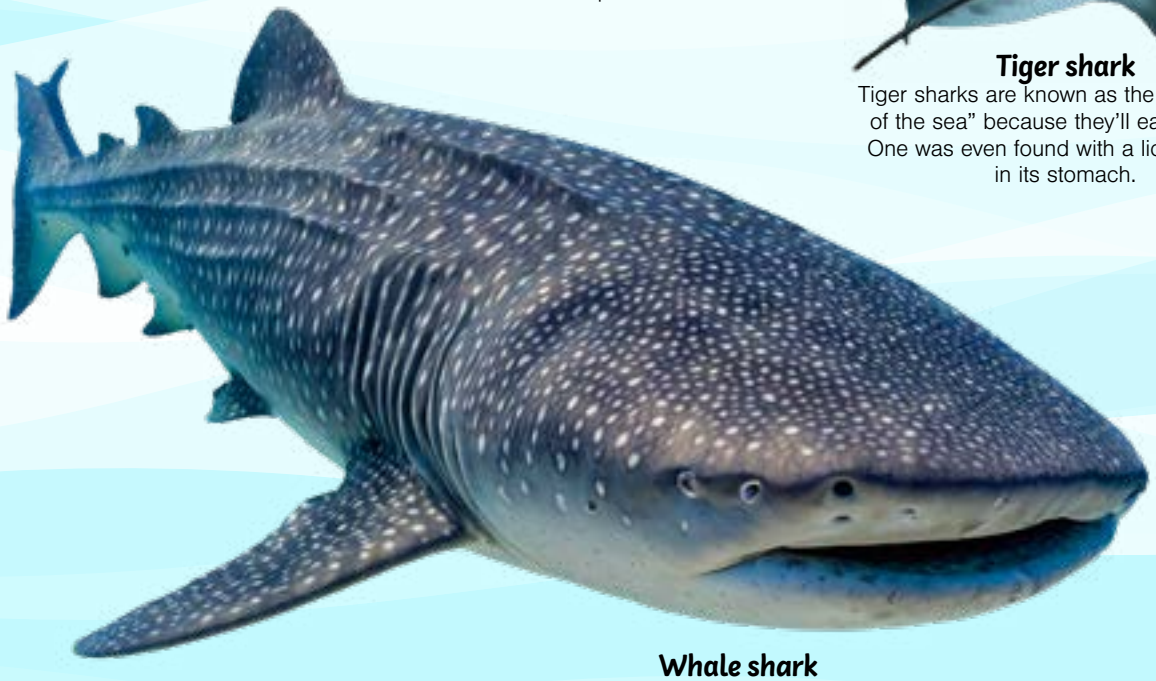
The shaggy appearance of wobbegong sharks led to their nickname: carpet sharks.

Blacktip reef shark

This species, found in shallow waters such as coral reefs and sand flats, is one of the most common sharks in the tropical Indo-Pacific.

Tiger shark

Tiger sharks are known as the “trash cans of the sea” because they’ll eat anything. One was even found with a license plate in its stomach.



Whale shark

Whale sharks are the biggest fish on Earth, but they only eat tiny marine critters, like plankton and krill.

NOT TO SCALE

SHARKS: COOKIECUTTER: CARLYN IVERSON/SCIENCE SOURCE; CARIBBEAN REEF, LEMON, AND TIGER: FRANTISEKHOUDYSZ/SHUTTERSTOCK; LEOPARD: DON HAMMOND/IMAGE SOURCE LIMITED/ALAMY; BLACKTIP REEF: ERIC ISSELEE/SHUTTERSTOCK; WOBBEGONG: JASON EDWARDS/PHOTODISC/GETTY IMAGES PLUS; GREAT HAMMERHEAD: KLETR/SHUTTERSTOCK; WHALE: BILALWEBDESIGNER/SHUTTERSTOCK

SPACE

‘Semi-heavy’ water ice swaddles baby stars

This ice could hold clues to the origins of water on Earth

Distant baby stars might shed new light on the origins of Earth’s water.

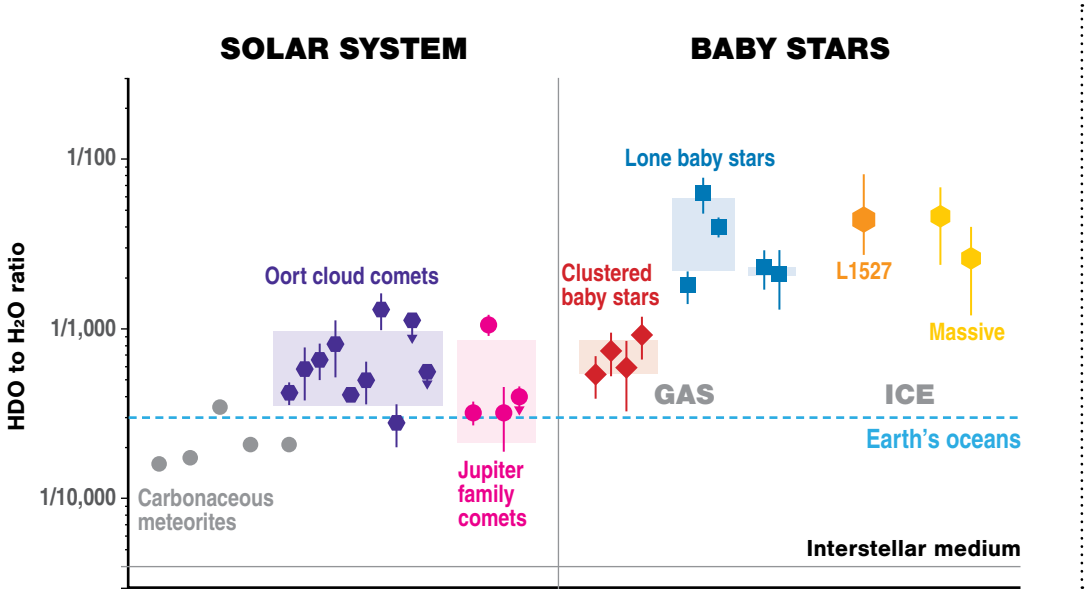
One clue to where water came from is how much of it is “semi-heavy.” In semi-heavy water molecules, one hydrogen is replaced with a hefty form of the element known as deuterium. Deuterium contains a neutron in its nucleus along with a proton. Instead of H_2O, semi-heavy water is HDO.

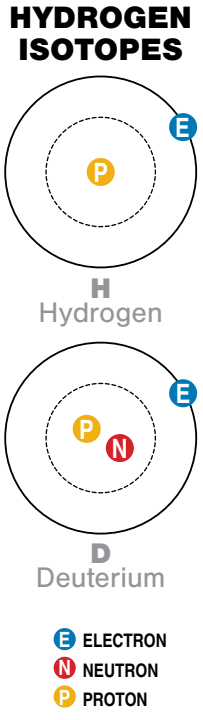
Water with a high ratio of HDO to H_2O likely formed in a very cold place. Say, a frigid, star-forming cloud of gas, dust and ice. Earth’s oceans have a higher ratio of HDO to H_2O than our sun does. That has led astronomers to suspect that some of our water came from ice in the dark cloud where the sun was born.

To find out, scientists need to know more about the ratio of HDO to H_2O ice in the chilly nurseries where sunlike stars form. Plus, how that ratio may change over a star’s lifetime.

The glow of baby star L1527 lights up the area above and below it in this snapshot taken by the James Webb Space Telescope.

NASA, ESA, CSA, AND STSCI. IMAGE PROCESSING: J. DEPASQUALE, A. PAGAN, AND A. KOEKEMOER (STSCI)





Astronomers compared the amount of "semi-heavy water" in or around objects in space. These included meteorites and comets in our solar system, plus other stars.

Researchers compared the ratio of semi-heavy water (HDO) to regular water (H_2O) around the **baby star L1527** (orange hexagon) with other objects. **Carbonaceous meteorites** (grey circles) come from asteroids that could have brought water to Earth. **Oort cloud comets** (purple hexagons) may have formed outside our solar system, while **Jupiter family comets** (pink circles) likely formed inside. Astronomers have studied both the gas and ice around other baby stars as well. Some of those **baby stars** are clustered in groups (red diamonds). Others are all **alone** (blue squares). JWST has also looked at two other, **larger baby stars** (yellow hexagons). Measurements for Earth's oceans are shown by a **blue dashed line**. The horizontal **black line** gives the HDO to H_2O value for the interstellar medium, the space between stars. This value is similar to that of our sun.

Astronomers used data from when the James Webb Space Telescope (JWST) peered at the star L1527. At just 100,000 years old, L1527 is an infant compared with our 4.5-billion-year-old sun. But its size and surroundings suggest it could grow up to look a lot like the sun. L1527 is gobbling up some of the gas and dust around it. What's left behind could someday form planets — as happened in our solar system.

JWST saw a fairly high ratio of HDO to H_2O ice in the stuff swaddling L1527. The researchers compared that ratio with the ice and gas around other baby stars, including slightly older ones. That suggested that the HDO to H_2O ratio around a star might not change much as the star evolves. The team also compared L1527's HDO to H_2O ratio with that of the ice seen on comets and meteorites in our solar system.

The team shared its findings in the *Astrophysical Journal Letters*.

These observations offer new details about what happens to water as stars mature. This may help scientists figure out where Earth's water came from. And that, in turn, could help pin down what it takes to make a planet habitable. But first, astronomers will need to observe the water around more baby stars.

— *Carolyn Wilke*

DATA DIVE

1. Look at the HDO to H_2O ratio for the interstellar medium. That's the space between stars, which has a similar value as our sun. How does its HDO to H_2O ratio compare with that of Earth's oceans?

2. How does the HDO to H_2O ratio of Earth's oceans compare with that of carbonaceous meteorites? What about with the two families of comets?

3. How does the ratio of HDO to H_2O ice around L1527 compare with that of the more massive baby stars viewed by JWST?

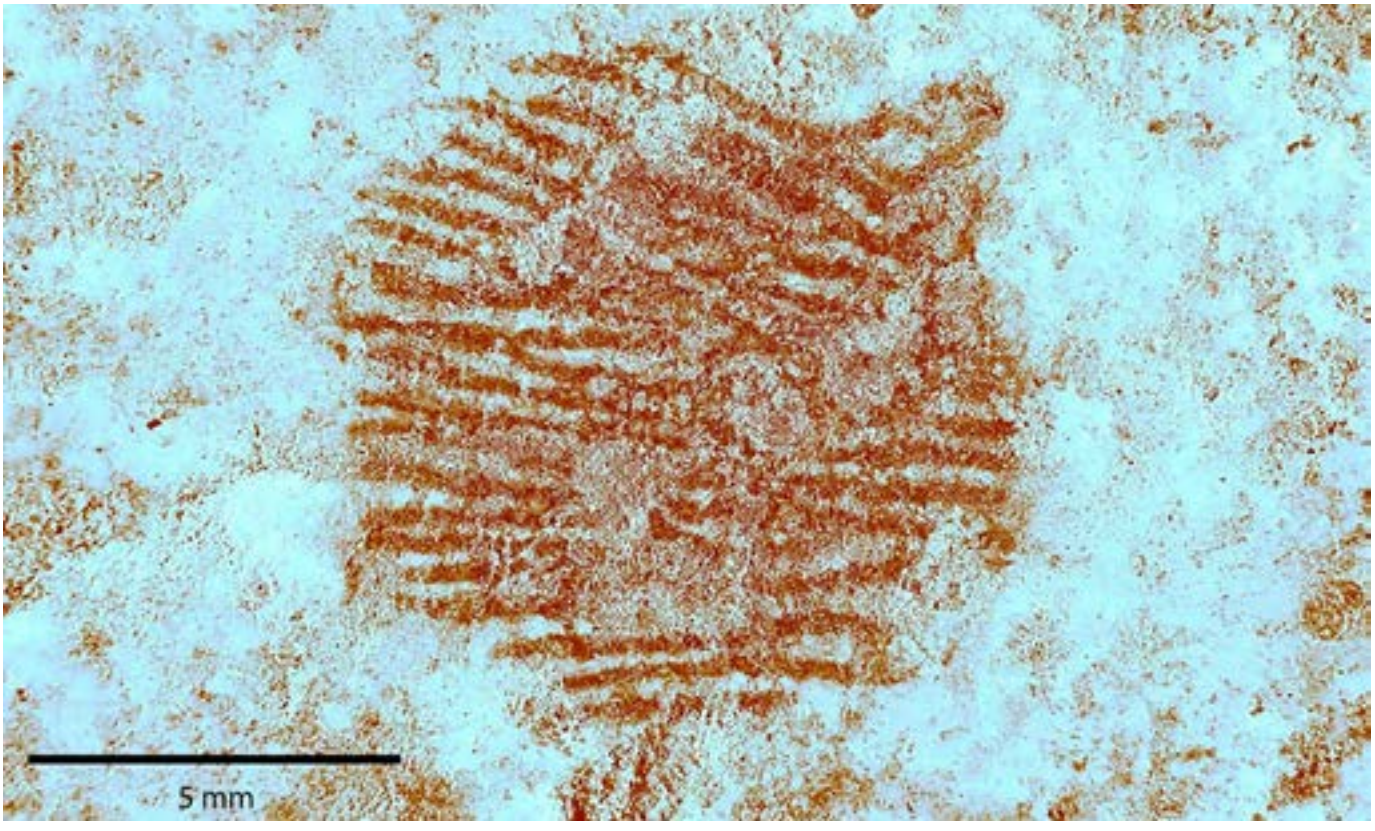
4. What might researchers find if they keep looking at more stars with JWST?

DATA: K. SLAVICINSKA ET AL/THE ASTROPHYSICAL JOURNAL LETTERS 2025

ANSWER

This may be the oldest Neandertal fingerprint ever found

The 43,000-year-old print was left in an ochre dot on a rock in Spain



In central Spain, archaeologists have unearthed a stone marked by a unique red dot. The spot of ochre pigment holds what may be the oldest, most complete Neandertal fingerprint ever found.

What's more, the rock is shaped sort of like a human face, with the red dot right where a nose might be. This hints that the Neandertal who made the mark was experiencing pareidolia, scientists say. Pareidolia is our tendency to see familiar shapes, such as faces, in random objects.

Researchers shared these findings in *Archaeological and Anthropological Sciences*.

Archaeologists dug up the dotted stone in 2022 at an ancient rock shelter near Spain's Eresma River. Carbon dating shows the rock emerged from a layer of earth dating back to around 43,000 years ago. That's near the end of Neandertal history.

"From the first moment, we saw that it had a red dot," says David Álvarez Alonso. A historian and archaeologist, he works at the Complutense University of Madrid, Spain. Images made using different wavelengths of light revealed fingerprint ridges in the smudge of pigment. Comparisons to modern fingerprint databases suggest it was likely left by a man.

Neandertal fingerprints found on other ancient objects were likely made during toolmaking. But the newfound print looks like it was made for some symbolic purpose.

— *Javier Barbuzano*

The fingerprinted stone was found in Spain at an ancient rock shelter called Abrigo de San Lázaro.

D. ÁLVAREZ-ALONSO *ET AL/ARCHAEOLOGICAL AND ANTHROPOLOGICAL SCIENCES* 2025

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? Ja Young Kim, a finalist at the 2025 Regeneron International Science and Engineering Fair, shares her experience.

Q What inspired your project?
A Ja Young lives on the small island of Saipan in the Western Pacific. While snorkeling with her dad in middle school, she recalls, she used to see the kaleidoscopic colors of local reefs. "It's pink! Blue! It's colorful inside," she remembers. Today, waves sweep fragments of bleached coral onto Saipan's beaches. Dying coral is "not just a story that we can hear from newsletters or books," Ja Young says. It's happening right before her eyes. So Ja Young teamed up with a classmate to design robotic nurseries that nurture baby corals.

Q What sets your project apart from others?
A Efforts to restore coral reefs can be quite costly, Ja Young notes. But the cost to build these new robotic coral homes is "way, way lower" than other strategies. That means the invention could be used by far more people, she says. Ja Young is also proud that she and her partner designed and 3-D printed their devices completely from scratch.

Q What challenges did you face?
A "The hardest part was that this is actually going into the ocean," Ja Young says. The coral-housing devices had to work well even in the unpredictable environment of the sea. "It's not just going to be limited to our own island," Ja Young adds. So the design will have to hold up to varying sea conditions around the world.

Regeneron International Science and Engineering Fair finalist

Ja Young Kim

Ja Young, 18, teamed up with classmate Jiho Kong to design a fleet of robotic apartment complexes for coral. These devices provide baby coral a safe place to grow up. They even track the environment and move away from stormy waters to keep their residents safe. Ja Young is a senior at Saipan International School. Saipan is the largest of the 14 Northern Mariana Islands, an archipelago north of Australia.

Learn more about the Regeneron International Science and Engineering Fair

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