Science News Explores
April 2023

RETURN TO THE WILD

VIDEO GAMES MAY IMPROVE MEMORY AND ATTENTION
P4

WELCOME TO THE METAVERSE!

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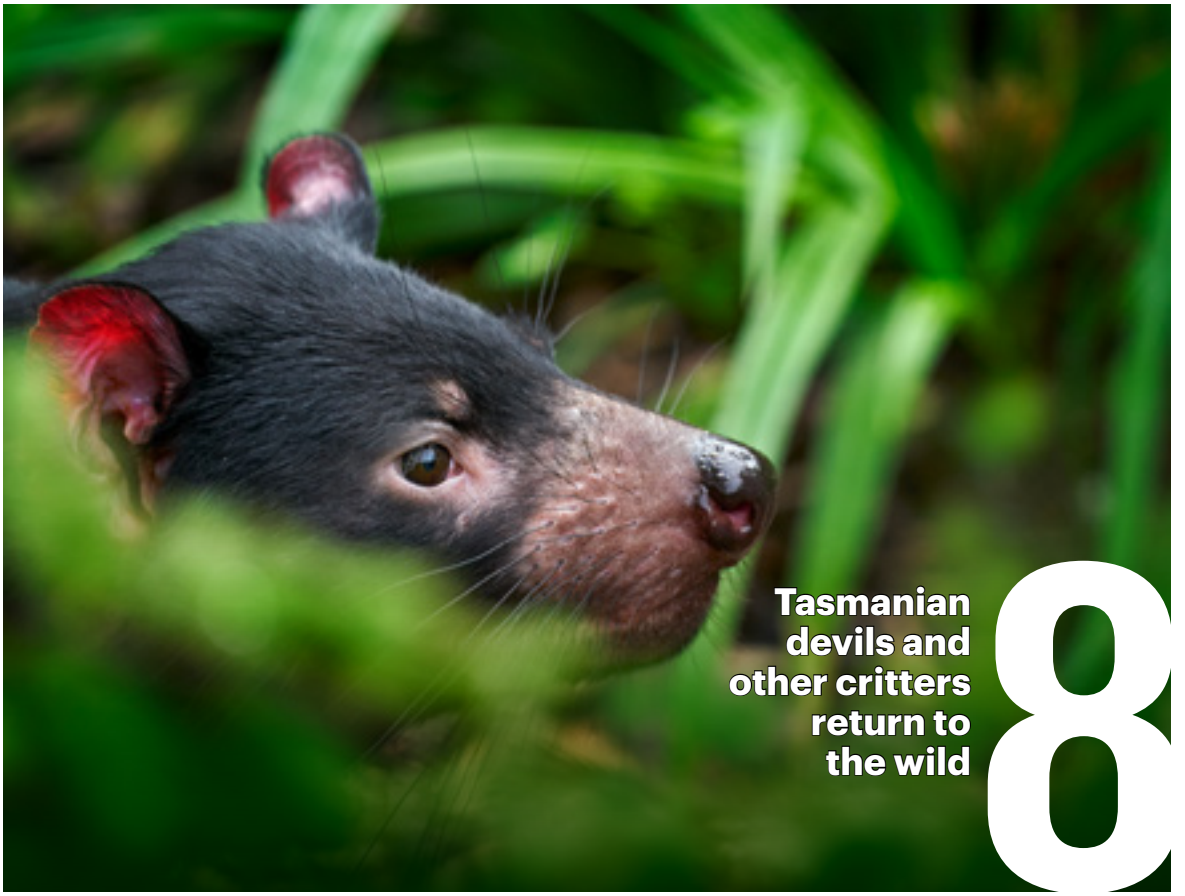

ONDREJ PROSICKY/SHUTTERSTOCK

NVIDIA OMNIVERSE IMAGE

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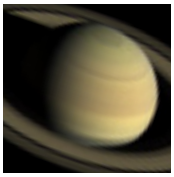

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Science News Explores
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202-785-2255

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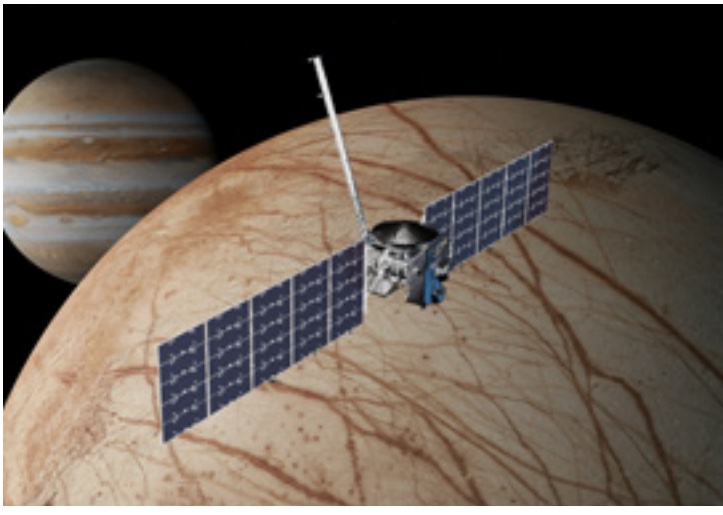
Q When will people be able to look for life on Europa?

— *Briar R.*

A In October 2024, NASA will launch the Europa Clipper mission. It won't look directly for life but instead will investigate whether this moon of Jupiter has the right conditions to support living things. Scientists think Europa holds a vast ocean of liquid water beneath its icy shell. By flying close to the moon's surface, the Clipper spacecraft will confirm whether that ocean exists. The spacecraft will also measure the potential ocean's size and whether it contains the right chemical ingredients for life. If the Clipper spacecraft finds places on Europa that could support life, a proposed Europa Lander mission could later continue the search more directly by touching down on the moon and collecting samples.



Q Why does cutting onions make you cry?

— *Dia H.*

A Onions belong to a group of smelly root vegetables that includes garlic and leeks. Humans cook with a part of these plants found underground known as the bulb. Onion bulbs absorb sulfur from the soil as they grow. The plant uses this sulfur to create chemical compounds that are stored in its cells. These substances may help defend the growing plant from predators and microbes. Cutting an onion breaks open cells and releases the stored sulfur compounds along with enzymes. These proteins kick start chemical reactions that produce a gas. This gas rises and mixes with the water covering your eyes to create sulfuric acid. Specialized sensory nerves on your eyes become aggravated, causing irritation. Your tear ducts produce tears to help flush away the irritating chemical.

Q Why are ants so strong?

— *Charlie N.M.*

A While it would be impossible for you to carry an object tens of times your own weight, this is no problem for a tiny ant. And it's the ant's small body that actually helps it get the job done! Ants have less surface area and thicker muscles relative to their body size than heftier animals, such as cats or people. As a result, these insects can apply more force to the objects they're lifting, relative to their size. An ant also wears its skeleton — called an exoskeleton — on the outside of its body. It can devote more muscle to carrying heavy objects and less to holding up its body. Ants aren't the only insect powerlifters around, though. The rhinoceros beetle and some other beetle brethren toss rival males during fights over mates. And dung beetles? They use all that muscle to roll around heavy balls of poop.

FIND OUT MORE USING THE QR CODES.

CORRECTION

In the February issue, we stated on page 28 that a liquid's atoms and molecules are less tightly packed than those of a solid. That is usually true but not in the case of water, which was the example molecule in that story. Thanks to the reader who pointed this out.

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

Sarah Zielinski
Editor, *Science News Explores*

JOSHIMERBIN/SHUTTERSTOCK

HUMANS

Can video games level up your brain?

Some gaming kids showed boosted memory and attention

Plenty of kids spend their free time playing video games. And plenty of adults — including parents — worry those games might be harmful to a child's developing brain. But a new study suggests games could offer some benefits to the mind.

Bader Chaarani studied brain scans from 2,217 9- and 10-year-olds from across the United States. He's a neuroscientist at the University of Vermont in Burlington.

The kids were part of the Adolescent Brain Cognitive Development Study. Every year, participants in this large study answer questions about their activities and physical and mental health. They also have MRI scans of their brains every two years.

Chaarani and his team compared scans from kids who reported playing video games at least three hours a day with those who didn't play at all. The researchers looked for differences that might be related to kids' cognition (ability to think and learn).

While in the MRI scanner, the kids performed two tasks. One asked them to press an arrow key that matched the right or left arrow on a computer screen. But if the arrow was followed by an arrow that pointed up, the kids were supposed to *not* press a key. The up arrow was a signal to stop. This task tested their ability to quickly act on that stop cue.

The second task asked the kids to remember facial expressions in pictures shown on the screen. They were supposed to remember the very first expression they saw. They also had to remember the expression they had seen two faces back before any given moment. This tested what's known as their working memory — holding and using short-term information in their minds.

As kids performed the tasks, the scanner recorded activity in their brains.

Gamers proved better at both tasks. Compared to non-gamers, they more often could stop themselves from clicking the key when the up arrow appeared. They also were better at remembering facial expressions. The researchers shared the findings in *JAMA Network Open*.

The scans showed parts of the brain involved in working memory, attention and problem solving were more active in gamers, too. That's not surprising, Chaarani says. "Games require fast-paced processing of many [types of] information." And, he adds, "they require problem solving, [and] a lot of visual attention."

Fran Blumberg works at Fordham University in New York City. There, she studies children's attention and problem-solving skills. She points out that the study didn't test if playing games caused the effects seen. Gamers did perform better than non-gamers on certain tasks in the study. And that matches up with differences seen in their brain scans. But, she notes, "We still need more studies to understand why."

The results might please gamers. "Don't jump to conclusions," Chaarani cautions. "Many media sources have been interpreting [the results to mean] video gaming is good for you. We're not saying that." Observed brain changes could come at the expense of other brain functions. He plans to keep studying whether and how kids' skills — and brains — may change over time.

— *Alison Pearce Stevens*

CHIMPINSKI, VLADIMIR SUKHACHEV/SHUTTERSTOCK

PHYSICS

How dandelions scatter their seeds

Each bit of fluff catches wind from a different direction

Dandelion seeds fly free on the breeze. But those on any given seed head have different destinies. Some are primed to float north. Others may drift east, south or west.

A seed's most likely direction depends on where it sits on the dandelion head, says Jena Shields. She's a biophysicist at Cornell University in Ithaca, N.Y. Seeds on the side facing a breeze will let go most easily. The others hold on tens to hundreds of times more tightly — until the wind shifts.

Shields measured the force it takes to pluck individual seeds. To start, she superglued a fine wire to the tufted ends. Then she used a machine to pull them from the seed heads at various angles. Those tugs mimic what happens when the wind, or someone's breath, pushes them over.

Each seed released most easily to a pull from one direction. The preferred angles varied from seed to seed. That helps prevent seeds from one head all going the same way. And it may explain why the plants are so successful at spreading. Once blown off a dandelion, a seed's umbrella-like tuft carries it on the breeze that pulled it away. Shields described her findings at a meeting of the American Physical Society's Division of Fluid Dynamics.

One exception: "A strong, turbulent wind can still send all the seeds flying in the same direction," Shields says. So a powerful gust — or an excited child — can blow off all the seeds at once.

— *James R. Riordon*

This device can measure the force needed to pluck a single seed by tugging on it.

BILLION PHOTOS/SHUTTERSTOCK; JENA SHIELDS/CORNELL UNIVERSITY

SPACE

Two mysteries, one moon

A single missing moon could explain Saturn's tilt and rings

A single, doomed moon could clear up a couple of mysteries about Saturn.

One mystery is why Saturn is tilted nearly 27 degrees relative to its orbit around the sun. Saturn couldn't have formed that way. And that tilt is too big to be from collisions knocking the planet over. The second mystery is why Saturn's rings are only about 150 million years old, while Saturn itself is more than 4 billion years old. The rings must have formed separately — but how?

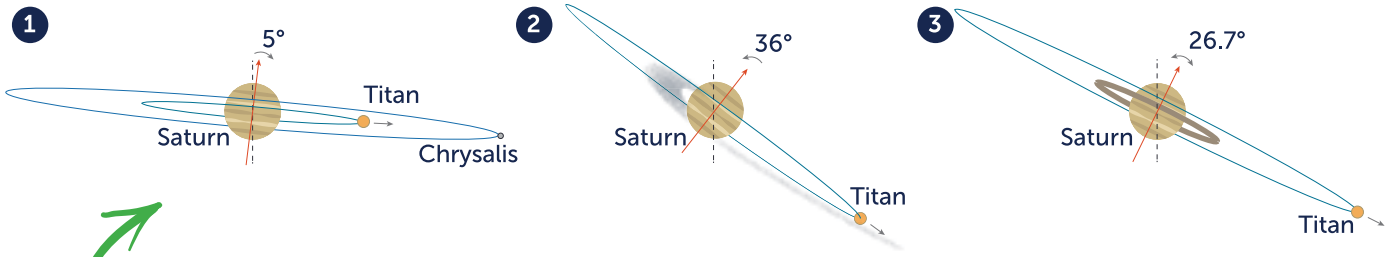
Researchers now suggest that one long-gone moon of Saturn could have helped knock the planet atilt and formed its rings. They've nicknamed the potential moon "Chrysalis." The gravitational dance between Chrysalis, Neptune and Saturn's largest moon, Titan, could have yanked Saturn over. That, in turn, could have thrown Chrysalis' orbit around Saturn into chaos. The moon would have eventually skirted too close to Saturn and been shredded by the planet's gravity. Its debris would go on to form some of Saturn's rings.

Computer models show that this scenario works. But it doesn't work all the time. Only 17 out of 390 simulated scenarios ended with Chrysalis breaking apart to create the rings. But this scenario being unlikely doesn't mean it's wrong. Massive, dramatic rings like Saturn's are rare, too.

Planetary scientist Jack Wisdom and his colleagues suggested this idea in *Science*. Wisdom works at the Massachusetts Institute of Technology in Cambridge.

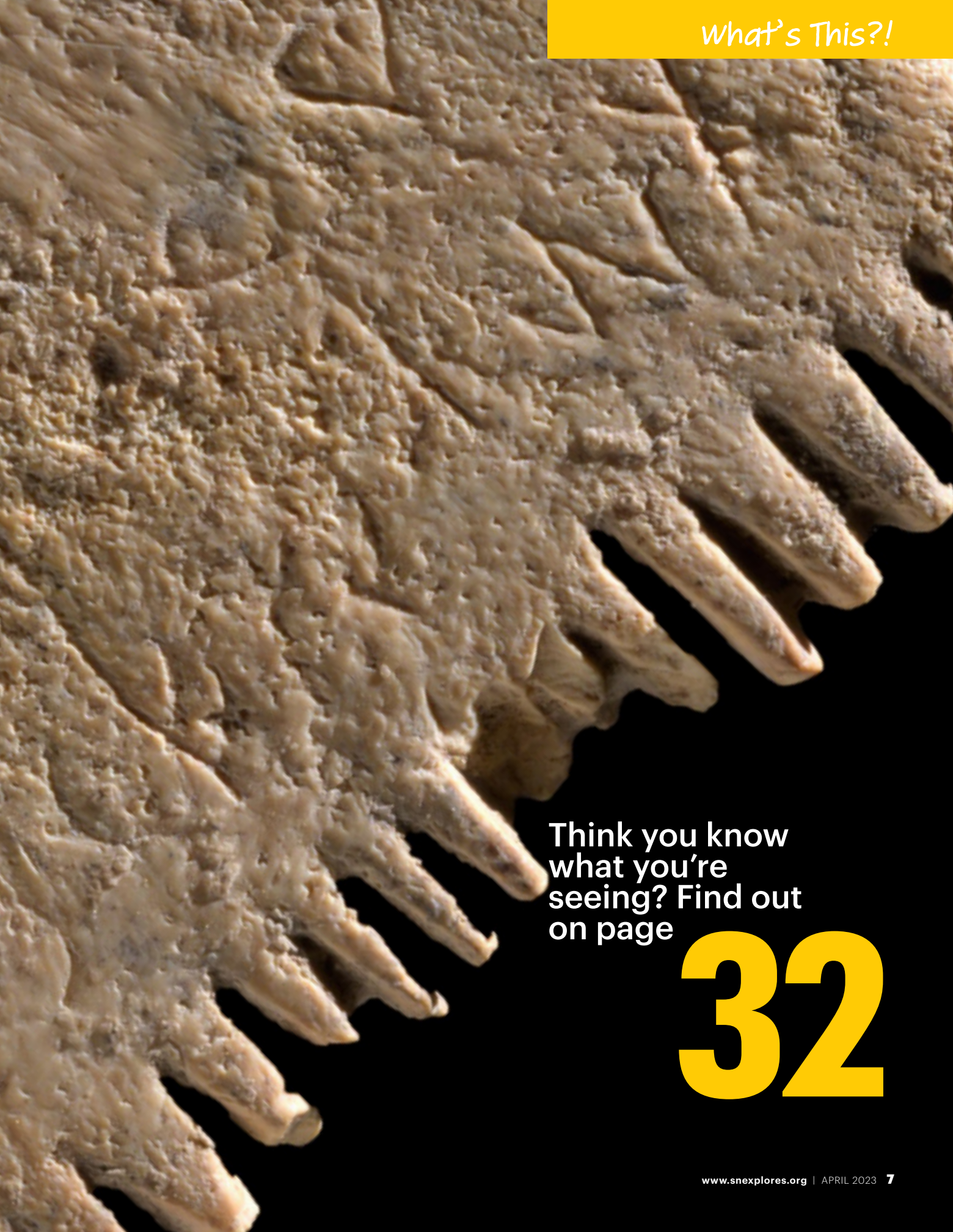
The name Chrysalis came from the moon's supposed spectacular ending. "A chrysalis is a cocoon of a butterfly," Wisdom says. "The satellite Chrysalis was dormant for 4.5 billion years, presumably. Then suddenly the rings of Saturn emerged from it."

— *Lisa Grossman*



Saturn's axis was probably close to vertical when it formed (1). But Chrysalis, Titan and Neptune could have tilted Saturn over about 36 degrees (2). After Chrysalis' demise, Saturn's tilt relaxed to about 27 degrees (3).

SATURN: SPACE SCIENCE INSTITUTE, JPL-CALTECH/NASA
DIAGRAM: E. OTWELL, ADAPTED FROM M. EL MOUTAMID/*SCIENCE* 2022



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

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RETURN TO THE WILD

Rewilding returns lost species to strengthen ecosystems >>

By **Alison Pearce Stevens**

AUSSIE ARK

In October 2020, a group of conservationists fenced in a large area of eucalyptus forest in the hills of southeastern Australia. They trapped and removed non-native foxes and feral cats. Then they trucked in and unloaded 26 PVC pipes. Each was wide and capped at both ends with a disk full of holes. They laid the pipes side-by-side on the ground beneath towering eucalyptus trees, then held their collective breath as they opened them.

A mottled nose poked out from one tube, followed by the rest of a pointy black head. Whiskers twitched. Then a Tasmanian devil — the world's largest carnivorous marsupial — eased out onto the forest floor. It was soon followed by the others — the first devils in the wilds of mainland Australia in 3,000 years.

Reintroduction of Tasmanian devils to the Australian mainland is part of an effort called rewilding. All over the world, species have been disappearing from parts of their native habitats. Often people are the cause. It might be due to hunting. Or the introduction of invasive species. Those intruders can sometimes out-compete or prey on the natives until those natives are all gone. Affected species didn't go extinct everywhere. But they were no longer part of the complex web of life in that particular place.

More and more, scientists have begun to reintroduce animals into spaces from which they had disappeared. The idea is that this rewilding will help return the ecosystem to its original state — or something close. By reintroducing animals, people can let natural processes work on their own.

"The basic idea of rewilding is to give space for nature to do its job," says Henrique Pereira. He's a biodiversity conservation researcher at the German Center for Integrative Biodiversity Research in Leipzig. "The idea is to step back from trying to control nature," he says, and let nature do some work for us.

New approach to restoration

Restoring ecosystems isn't new. For decades, scientists have been replanting forests, reseeding prairies and finding ways to help fish and other wildlife move around dams. These changes are meant to undo earlier changes created by people, such as clear-cutting of forests for timber, plowing prairies for crops or channeling rivers. That may be good for people, buildings and our need for food. But such changes alter natural ecosystems in ways that can make them less likely to function properly.

And we need ecosystems that function well. We rely on all types of services that those ecosystems provide. Plants often get the most attention here. They produce the oxygen we need to breathe. Many remove pollution from air and water. Plants also remove carbon dioxide, a greenhouse gas, from the atmosphere and store it.

In the last decade or so, though, more attention has turned to the animals in these ecosystems. Animals play important roles in their food webs. Insects pollinate flowers so that plants can reproduce. Herbivores mow down plants, keeping them from getting too abundant. Carnivores keep herbivores in check, so they don't wipe out the plant life. A functioning ecosystem is a balancing act. All players are essential to keep things running in a healthy way.

So researchers around the world are beginning trial introductions of animals to ecosystems. These aren't randomly selected animals. They're animals that once lived in the area — or are similar to those that did. Most are species that went extinct locally but exist elsewhere. By returning populations to these struggling ecosystems, scientists hope to return these systems to a more natural state.

These devil joeys were born in captivity at Aussie Ark. They will eventually be released in mainland Australia.

AUSSIE ARK

The devil's in the details

Tasmanian devils were once an important part of the Australian ecosystem. They mainly scavenge dead animals, explains Hayley Shute. She is the conservation manager for Aussie Ark. This organization in Tomalia, New South Wales, works to protect endangered species. And devils help protect native species by driving away feral cats and foxes. Cats and red foxes were introduced to Australia by European colonizers. Widespread populations of these animals now threaten many small mammals on the continent, such as bilbies, quolls and potoroos. These animals are found nowhere else on Earth.

"The Tasmanian devil isn't an apex predator," Shute notes. That's a predator at the top of the food chain. It helps control populations of other animals. Still, she explains, the devil "fills some of that role" by keeping invasive cats and foxes away. Aussie Ark hopes to eventually have populations of free-living devils in Australia. This would help protect smaller mammals and allow native predators, such as quolls and birds of prey, to control populations of herbivores.

Aussie Ark is also hoping to protect wildlife "by creating insurance populations," Shute says. These are populations of animals reared in safe places — in case something happens to the wild populations.

Their efforts show real promise. "Australia has the worst mammal extinction rate in the entire world," Shute notes. But rewilding efforts can go a long way to making sure future generations enjoy the same wildlife people do today.

Steppe back to the past

In northern Siberia in Russia, Nikita Zimov and his team arrive at Pleistocene Park in two large trucks carrying fur goats and camels. They're weary. It took a full month to relocate the animals from a farm near Moscow, traveling by truck and boat.

Zimov's father, Sergey, started Pleistocene Park in 1996. It's an experiment to see if reintroducing grazing animals to the Arctic can help restore an ecosystem that existed thousands of years ago. Called mammoth steppe, this ecosystem was mostly grasses with some shrubs and trees. Large grazers — including now-extinct mammoths — created and maintained that ecosystem. Bringing it back could help fight climate change. Or so the Zimovs hope. Their idea is that steppe will keep the ground frozen year-round. This could prevent the release of greenhouse gases from thawing soil.

The team unloads the goats, including two kids born during the trip. Then come the camels. The new arrivals join other animals at the park. Muskox, reindeer, moose, bison, yak, sheep, Yukatian horses and Kalmykian cows have arrived over the years. Many once lived in the ancient ecosystem. Others, such as cows, graze similar types of plants. Their home is a 20-square-kilometer (7.7-square-mile) enclosure within the 144-square-kilometer (55.6-square-mile) park.

When the grand experiment began, the area was tundra. Most of the ground was permafrost, a thick layer of soil that remains frozen year-round. But the permafrost has been thawing. That releases methane into the atmosphere. This potent greenhouse gas

These Aussie Ark keepers are preparing to release more Tasmanian devils into an Australian enclosure.

AUSSIE ARK

contributes to climate change. Reintroducing grazing animals to this landscape might help prevent this. Their feet will trample snow, exposing the ground to extreme cold in winter. This will help keep permafrost frozen. As grasses begin to take over, their deep roots will store carbon underground. Grasses reflect more light and heat than existing tundra plants, which could help cool the area, even in summer.

Twenty-five years into the rewilding effort, the ecosystem is changing. Grasses are spreading across the enclosed area. That's not all. A team of researchers confirms that those grasses are increasing the amount of carbon stored in the soil. And the soil stays colder. In winter, soil temperatures are as much as 14 degrees Celsius (25 degrees Fahrenheit) colder than soil in untrampled areas. This helps keep the permafrost frozen year-round, even though summers have been getting warmer.

But the work here is far from done. The team would eventually like to see millions of animals, including predators, inhabiting millions of square kilometers of land. "The more diverse is the ecosystem, the better," Zimov says.

Fighting an upstream battle

Molly Alves checks in on her wards: two displaced beavers. For now, the pair is living in a fish hatchery on Tulalip Tribes land in western Washington. But the rest of the beaver family is still out in the wild. Alves and Dylan Collins load up their truck and head out to find those animals.

Alves and Collins are wildlife biologists with the Tulalip Tribes Natural Resources Beaver Reintroduction Project. The project is using beavers to improve salmon habitat. Young salmon, called fry, need cool pools of still water. Beavers are experts at providing it by damming streams and rivers.

But beavers were hunted to near extinction in the 1800s by people who wanted their fur for coats and hats. Since then, the animals have been making a slow comeback. However, there's a problem. Beaver dams can cause flooding. Where this happens near cities and other populated areas, the beavers are considered a nuisance.

Normally, such "nuisance" beavers would be killed. But the Tulalip Tribes came up with an alternative solution: Relocate the beavers onto land within the Tulalip's Ceded Territory. Most of these beavers are released along mountain streams northeast of Seattle in the Mount Baker Snoqualmie National Forest.

The biologists use computer models to find mountain streams that would make good beaver habitat. They visit potential locations and rate them with a "site scorecard" to determine which ones would work best. Then it's time to bring in the beavers.

"We're working with wild animals that are highly mobile," Alves says. "So they don't always stay right where we put them." But if the beavers make it to the following spring, they'll likely stay in the spot for good. They build dams, lodges and channels that create wetlands. Animals of all types seek refuge in that new habitat, including salmon fry. The beavers help protect salmon populations, just by doing what beavers do.

And all those wetlands supercharge the soil with water. The dams slow the flow of water downstream to Puget Sound and the Pacific Ocean. That's not only essential for fish. It's also critical for people at a time when heat waves and drought have become a growing problem. "Beavers store freshwater," Alves says. They can even help suppress wildfires. Wetlands can act as a fire break, preventing fires from spreading to new areas, Alves says. And after a fire, unburned areas around the beaver ponds provide a place for other wildlife to hide and recover.

Molly Alves and her team (top) prepare to release a family of beavers in the Mount Baker Snoqualmie National Forest. After the beavers are released (bottom), they investigate their new home.

The trick for all of these rewilding efforts is helping people understand why we need the animals on the land. They're part of an ecosystem. And returning them can help reduce and even reverse the harmful effects people have had on natural systems.

We can't survive without healthy ecosystems. "The next time you see a beaver or beaver dam," Alves says, "consider yourself lucky for having this climate superhero as your neighbor!"

Efforts to reintroduce animals to ecosystems are already showing positive results. And the projects described here are just the beginning. Rewilding offers "the opportunity to re-create our natural ecosystems and increase the animals and plants that are within them," say Benis Egoh and Charity Nyelele. The two conservation biologists worked together at the University of California, Irvine. Nyelele is now at the University of Virginia in Charlottesville.

Rewilding is "one of the only effective tools in regaining nature," they say. It addresses problems created by people. It also brings major benefits. "For us to achieve our goal of conserving nature for future generations," Egoh and Nyelele say, "we must put a lot of effort into rewilding and restoring nature."

Read More

Nature's Best Hope
(Young Readers' Edition)
—by Douglas W. Tallamy, adapted by Sarah L. Thomson

Did you know outdoor cats kill up to 4 billion birds in the United States each year? Find out how you can help local wildlife right from your backyard in this handy, how-to guidebook!

KARI NEUMEYER; TIMBER PRESS

This reproductive biologist works to save endangered species

Pei-Chih Lee preserves tissues to help vulnerable animal populations

During March 2020, when many people were hunkered down at home because of the COVID-19 pandemic, Pei-Chih Lee and her colleagues were hard at work at the Smithsonian National Zoo in Washington, D.C. They wanted to ensure that one of the zoo's giant pandas, Mei Xiang, had her best chance of having a baby that year.

The team usually used fresh sperm collected the same day when artificially inseminating a panda. But Lee and her colleagues needed to minimize in-person contacts and had to use frozen sperm, even though they weren't sure it would work. That summer, though, they found success. Mei Xiang gave birth to a healthy male cub named Xiao Qi Chi, or "Little Miracle." The cub was the first U.S.-born giant panda born via artificial insemination with previously frozen sperm.

Helping pandas is just part of the job for Lee. A research biologist at the Smithsonian's National Zoo and Conservation Biology Institute, she collects reproductive cells and tissues for the National Zoo's genome resource banks. These banks preserve genetic material that can help researchers learn more about endangered animals, rebuild populations and breed species in captivity. Lee has also worked to find new methods of preserving these specimens by drying them out with microwave radiation. In this interview, Lee shares her experiences and advice with *Science News Explores*. (This interview has been edited for content and readability.) — *Aaron Tremper*

To prepare the sperm to artificially inseminate the panda Mei Xiang, Lee first had to thaw it out in the lab.

As part of her job, Lee (inset, with her dog Storm) talks to the public at outreach events like this one.

Q What inspired you to pursue your career?

A I've always loved animals. As a kid, I would go outside and find all these little creatures in nature. I'd watch Animal Planet and all those animal documentaries. So for me, it was very natural to study biology. Then I got into molecular and cellular biology. It's interesting because you have all these tools to solve a puzzle. Then you unlock the next one and the next one.

Q What's one of your biggest successes?

A I would say this drying technique that we've been developing to preserve reproductive tissues and cells. The technique is inspired by natural organisms that can survive in this dried state for a very long time. A good example is the tardigrade, which can survive super harsh conditions. We are trying to take what scientists have already learned from these different species and re-create that in the lab. It's not very easy to do. Mammalian cells don't really have the tools that these natural organisms have that can help them survive really dry conditions.

We're mainly focused on using the domestic cat as our model organism right now. We were able to dry cat sperm and store it for over a year. We were then able to inject that sperm into a fresh oocyte (egg) and produce cat embryos from it.

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

A I wish I knew this job existed! When I was younger, I had a naive idea that if I wanted to study and save wildlife, I'd have to do the type of research that primatologist and conservationist Jane Goodall does. Now that I'm here, I've learned that the work I do can also contribute to conservation. There is more than one path to take you to what you want to do. So just go explore.

P.-C. LEE

WELCOM METAVE

If you play Fortnite or Minecraft, you're already part of this growing virtual universe >>

By **Kathryn Hulick**

ME TO THE ERSE!

A teen with spiky white hair races his car past an enormous *Tyrannosaurus rex*. Later, he dances to some catchy music — while spinning and floating in midair. These scenes from the 2018 hit movie *Ready Player One* take place in a virtual world. The teen, Wade Watts, describes it as "a place where the limits of reality are your own imagination. You can do anything, go anywhere."

ARINJAY

A virtual place like this has a name — the metaverse. That name comes from Neal Stephenson's 1992 science fiction book, *Snow Crash*. In these fictional stories, the metaverse transforms humanity and our world. It offers a tempting escape from a reality that has gone horribly wrong.

Meanwhile, in the very real here and now, engineers, businesspeople and even kids are building an actual metaverse. It's not very much like the immersive, realistic virtual worlds of science fiction — at least not yet.

The metaverse isn't just one thing or one place. It's a collection of "shared virtual worlds," explains software engineer Liv Erickson. They have extensive experience developing virtual reality software. In the metaverse, they say, people can connect and collaborate together. Just as the internet connects many different types of websites, images and videos, the metaverse is beginning to connect many different types of games, apps and experiences. Most of them will be 3-D and social.

One day, says Jeff Kember, people will visit the metaverse for "everything from hanging out and being social, to working on collaborative projects, performing experiments and visiting new places, real or imagined." Kember is a 3-D designer with experience in making video games and movies. Now he works on a software platform called Omniverse at the tech company NVIDIA. Its headquarters are in Santa Clara, Calif.

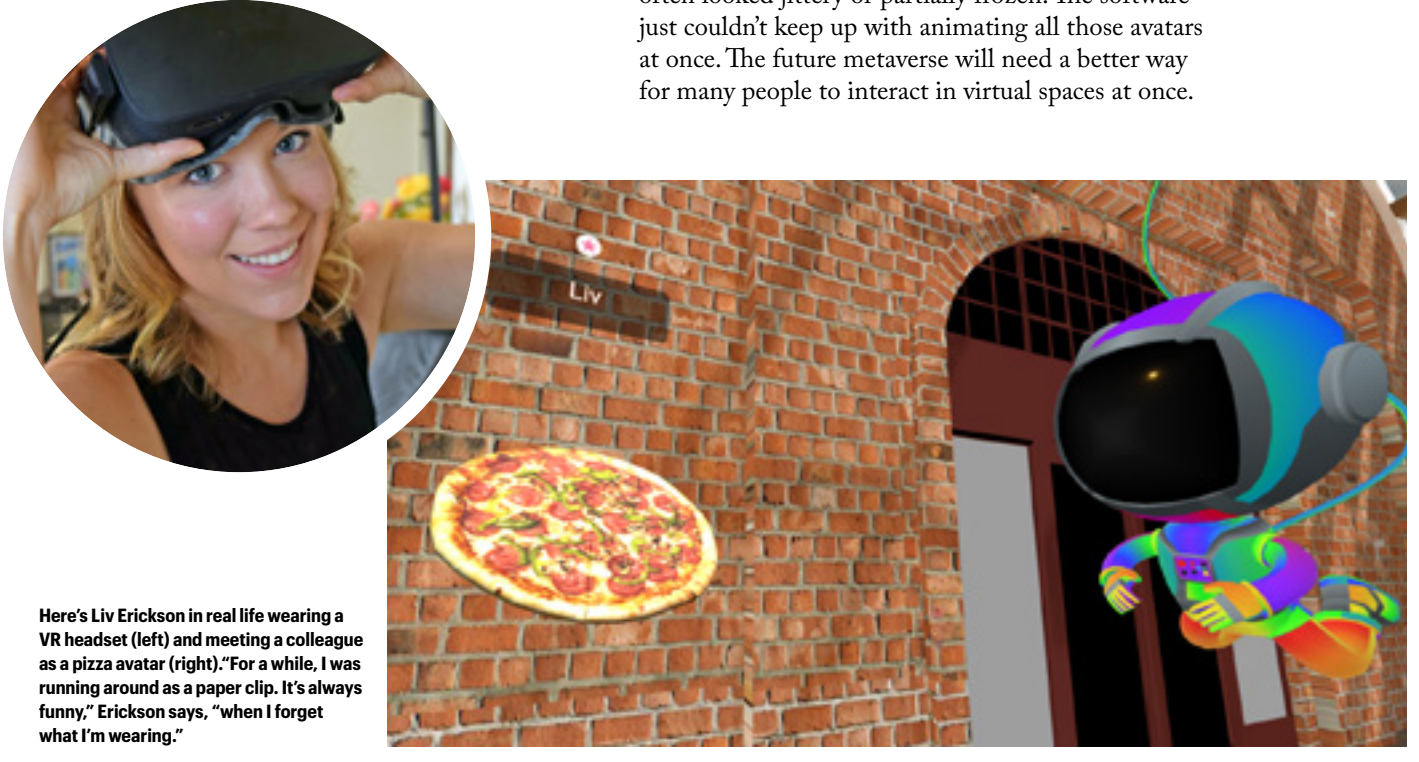
You are one of the people who will decide what the metaverse will become and how we will later use it. Will the metaverse offer an escape from reality? Will it instead enhance reality with new layers? Will it track our every move and deluge us with advertising? Or will it encourage new ways to create and connect with others?

The evolving metaverse

The internet is one parent of the metaverse. Video games are the other. Some games — especially Roblox, Minecraft and Fortnite — have become more like destinations in the early metaverse. People go there not just to play but also to hang out with friends and have memorable experiences.

In April 2020, the raging pandemic meant it wasn't safe to attend concerts in person. So hip-hop artist Travis Scott put on a free show inside the game Fortnite. More than 12 million people showed up as avatars and watched. The concert set a record for the most people ever participating in a game event at one time.

Technically, those millions weren't all in one huge virtual space. Fortnite split them into groups of 100. Each group viewed its own stream of the same concert. Erickson explains, "Generally speaking, it's hard to simulate a lot of humans in one spot — we move too much." The most people they've ever seen in one virtual space was around 420. And "that was a very uncomfortable experience," they say. People often looked jittery or partially frozen. The software just couldn't keep up with animating all those avatars at once. The future metaverse will need a better way for many people to interact in virtual spaces at once.



Here's Liv Erickson in real life wearing a VR headset (left) and meeting a colleague as a pizza avatar (right). "For a while, I was running around as a paper clip. It's always funny," Erickson says, "when I forget what I'm wearing."

L. ERICKSON

NVIDIA OMNIVERSE

In immersive gaming platforms, such as World of Warcraft (above), players can explore, collaborate and create their own adventures.

Another reason to visit metaverse-like games is to tinker, design and build. Often, you can even sell what you've created. On the game platform Roblox, people can make their own games and items. They can also spend real money on games or accessories for their avatars.

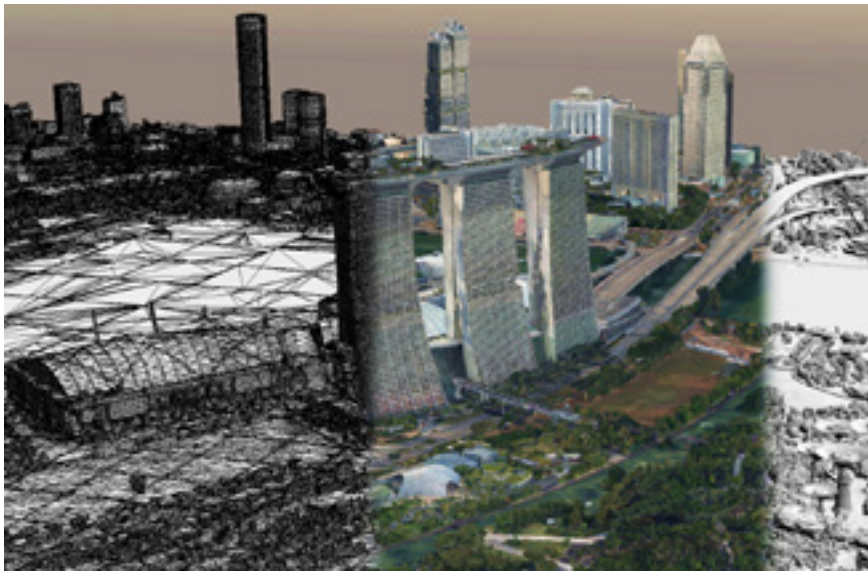
Samuel Jordan, who also goes by the handle Builder_Boy, joined Roblox as a teen in 2011. Now, he's a successful fashion designer. In 2021, he made $1 million selling virtual earrings, jackets and more.

Evo Heyning has spent time on Roblox and many similar platforms. But Heyning is not trying to become a millionaire. They're making art and experiences. "You can build a roller coaster," they say, and "test out ideas." They also are meeting people. "I feel as connected to my virtual friends as I feel to my physical friends," Heyning says.

Heyning has been producing and creating interactive media since they started playing Second Life in 2005. This game offered an early glimpse into the metaverse. It mimics real life. Inside it, avatars set up homes, meet other avatars and buy virtual items. Heyning once worked with a team in Second Life to build an interactive musical instrument. In 2009, they built a real version of this same instrument — called "Interactivation" — and displayed it at a Maker Faire festival.

Now, Heyning helps run the Open Metaverse Interoperability Group. This group is working on building a metaverse that will not belong to any one company. That's important because the technology that makes an immersive experience possible has to capture a huge amount of data about someone. If one company controls the metaverse, it would also control all of that information. It could use people's data to manipulate or advertise to them. That's a scary idea.

In a so-called "open" metaverse, people would keep control of their own data.



Space for everyone

Many people play video games because they love to dive into fantasy and become someone else. Some people even get addicted to gaming or to the internet. Certainly, some people could get addicted to the metaverse or use it to hide from reality. But being in the metaverse doesn't mean you have to leave the real world behind. This digital environment can mesh with the real world in fascinating ways. People can test out ideas virtually and then bring those ideas to life — as Heyning did with their musical instrument.

Or people can take parts of the real world and make them virtual, available for anyone to experience. This is what Kai Frazier is doing.

Frazier used to teach middle-school history outside of Washington, D.C. "A lot of my students had never left our neighborhoods," she says. She wanted to take her students to the museums in the city. The museums were free, but her school couldn't afford the buses to get there. Frazier set out to solve this problem.

She sold everything she owned and moved to Oakland, Calif., to start the company Kai XR. It launched in 2020. Now it provides students with virtual field trips and a makerspace where they can design things in 3-D. On one of the field trips, students explore the official Obama portraits at the Smithsonian Institution's National Portrait Gallery. Another "trip" takes them around the lab where the groundbreaking CRISPR gene-editing technology was developed.

Frazier has no tech background. Sometimes she has felt out of place. Still, she says it's important for her to show up and make her ideas a reality. "I was a homeless child," she says. "It taught me to be really resourceful and really scrappy."

Kids and teens experiencing homelessness or poverty may need extra help to take part in the metaverse. For example, they may only have access to a shared family smartphone. That's why Frazier made sure her virtual field trips work on any device. She also has partnered with companies that are putting Kai XR onto tablets. These will be made available for free at some schools.

Virtual models of the real world make it possible to visit places and meet people who would normally be out of reach. Plus, you can also become people of many different backgrounds and experience different cultures. You can literally walk a mile in someone else's shoes. Erickson loves how this flexibility of identity gives people power over how they want to show up online.

But it may not always be a good thing.

"I have this fear," Erickson says, "that I'll meet someone on an online platform and develop a friendship, only to realize it was a bot designed to be my friend and sell me products."

Bots and scammers already exist online. Their tricks may become more harmful when they are avatars with bodies instead of names with profile pictures.

Creating metaverse 'twins'

Virtual models can help people design a better real world to actually live in. Digital twins are simulations of real things or places. This isn't new technology. NASA created the world's first digital twins of

Above left: Kai Frazier (left) and biochemist Jennifer Doudna (right) worked together on a Kai XR tour of Doudna's lab, which explores the science behind the gene-editing technique CRISPR. Above right: One of the first steps in creating a digital twin is making detailed 3-D maps, such as this one of a section of Singapore.

KAI XR; SINGAPORE LAND AUTHORITY

Where should solar panels be placed? Using a digital twin of the city, researchers in Singapore figured out that the rooftops colored red receive the most sunlight.

Hui Ying Teo, a geomatics engineer with the Singapore Land Authority, helps make realistic 3-D maps. A good digital twin needs accurate, reliable, high-resolution data, she says.

spacecraft in the 1960s. However, in the metaverse, digital twins become immersive. These 3-D virtual copies feel like the real thing. What's more, multiple people can work with them at once.

Engineers are making digital twins of everything from cars and jet engines to entire factories. With a digital twin, people can test out ideas before making expensive changes in reality. They can also update the digital twin as new data come in from sensors in the environment or on the same device or building. That makes it possible to predict and fix problems before they risk becoming major failures.

Entire cities can have digital twins. Michael Jansen is a founder and chief executive of Cityzenith. This company makes computer programs that cities can use to create a digital twin. "Sometimes people call it Minecraft for architects," Jansen says of this software. City planners use the twin to virtually try out technologies that might improve how buildings in their cities function or use resources, such as energy.

Singapore, a city that is also a country in Southeast Asia, was one of the first to create a digital twin. To do this, the city first needed to create detailed 3-D maps. It started working on these back in 2014. And it is still carrying out regular 3-D mapping surveys to keep its virtual twin up-to-date. The more detailed and accurate these maps are, the more people can do with the digital twin.

A research institute at the National University of Singapore, for instance, did a study on which buildings could capture the most solar energy. This will help the city decide where to put solar panels. The digital twin will also help provide detailed mapping info that will allow robots, drones, self-driving cars and other vehicles to navigate the city.

Digital twins aren't perfect, of course. They may not accurately match reality. Also, bad guys could potentially hack a digital twin to plan an attack or disrupt important services. For these reasons, Singapore doesn't make all of its digital-twin data publicly available.

The metaverse will likely contain some fun fantasy worlds and games such as the ones in the movie *Ready Player One*. But when fully realized, the metaverse will be so much more than that. It will mirror the real world and enhance our understanding of it.

The future isn't something that happens to us — it's something we all create. And all of our voices matter. "Everybody has a role in creating the metaverse," says Frazier. If you feel there's no place for you, then "make your own place," she says. What type of metaverse do you want to create?

SINGAPORE LAND AUTHORITY

CHEMISTRY

Make a hot dog mummy!

Mimic ancient Egyptians' strategies to preserve the dead

By Science Buddies

Ancient Egyptians used mummification to preserve the bodies of their dead. One key step in that preservation process was drying the body out. Embalmers did this by covering corpses in natron, a natural salt mixture that contains desiccants. Those are substances that suck up water from their surroundings. In this experiment, observe how one desiccant found in natron — baking soda — affects a homemade hot dog mummy. Do not eat the mummified hot dog, though, as you could get sick.

OBJECTIVE

Study the science of mummification by mummifying a hot dog using baking soda

EXPERIMENTAL PROCEDURE

1. Measure the length, circumference and weight of a hot dog. Record those data in a notebook.

2. Pour at least 2.5 centimeters (1 inch) of baking soda into a box. Lay the hot dog on top, and cover it with another 2.5 centimeters of baking soda.

3. Seal the box and put it in a shady place indoors away from heating and cooling vents — no peeking!

4. After one week, remove the hot dog from the baking soda and measure its length, circumference and weight. Note any other changes to the hot dog, such as its color or smell. Record the data in your notebook.

5. Using the same hot dog but new baking soda, repeat the hot dog storage process for another week.

6. Remove the hot dog from the baking soda again and measure its length, circumference and weight. Record those data and any other changes to the hot dog.

7. Graph your data on the hot dog's length, circumference and weight to see how the hot dog mummy changed over time.

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

SCIENCE BUDDIES

ILLUSTRATION BY STEVE MCCRACKEN

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 will appear more than once. Can you find them all?

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

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IMMUNE
IVORY
LIGHTNING
METAMORPHOSIS
METAVERSE
MOON
MUMMIFICATION
PHONETIC
REWILDING
SALT
VIRTUAL

PATPITCHAYA/SHUTTERSTOCK

HUMANS

Asthma treatment may also help tame cat allergies

Adding the therapy to allergy shots reduced beastly symptoms and provided longer relief

Adding an asthma therapy to allergy shots may help tame cat allergies. A new combination treatment reduced allergy symptoms. And its relief lasted for a year after people stopped getting the shots.

Allergies rile up the immune system (see explainer on page 28). That creates irritating symptoms: itchy eyes, sneezing, runny nose, congestion and more. For more than a century, allergy shots — a type of immunotherapy — have been used to reduce such symptoms. The shots contain tiny amounts of the things people are allergic to, called allergens. People get shots weekly to monthly for three to five years. This gradually builds a tolerance to the allergen. The treatment can essentially cure some people of their allergies. But others never stop needing the shots.

Scientists still don't know exactly how allergy shots work, says Lisa Wheatley. She's an allergist at the National Institute of Allergy and Infectious Diseases. It's in Bethesda, Md. Allergy symptoms will get better after a year of receiving shots. But stop after that year and those benefits disappear, she says.

Wheatley is part of a team that wanted to improve allergy therapy. The researchers hoped to reduce the amount of time shots were needed while also giving patients long-lasting relief. The team also hoped to better understand how immunotherapy works.

IMMUNE SYSTEM ALARM BELLS

When allergies strike, some immune cells produce alarm chemicals. They trigger symptoms including inflammation. It's one of the body's distress responses. Too much inflammation can be dangerous. It can cause swelling and make breathing difficult. "If we could dampen the signaling that says 'danger,' we could maybe improve immunotherapy," Wheatley says.

She and colleagues turned to antibodies. Those proteins are part of the immune system's response to things it sees as dangerous. The team used a lab-made antibody called tezepelumab. It blocked one of those alarm chemicals. This antibody has already been used to treat asthma. So Wheatley's team knew it is generally safe.

The researchers tested the antibody on 121 people with a cat allergy. Dander — a protein in cats' saliva or dead skin cells — causes the beastly symptoms. For one year, the team gave participants either standard allergy shots alone, the antibody alone, both of those or a placebo. (A placebo doesn't contain any medicine.)

A year after treatment ended, the team tested participants' allergic response. They squirted cat dander up the noses of these people. On its own, tezepelumab was no better than a placebo, the researchers found. But people who got the combo had reduced symptoms compared with those who got standard shots.

The researchers shared these findings in the *Journal of Allergy and Clinical Immunology*.

Fel d1 is produced in salivary glands in the mouth and sebaceous glands in the skin

People can encounter the protein by touching a cat, touching furniture or other items, or even by breathing in the air where a cat lives

The exposure to fel d1 triggers a reaction, such as sneezing, in those who are allergic to the protein

LEFT TO RIGHT: UTEKHINA ANNA; IMTMPHOTO; PATHDOC/SHUTTERSOCK

QUIETING ALLERGY TRIGGERS

The combination treatment dropped levels of allergy-triggering proteins. These proteins are known as IgE. And they kept falling even a year after treatment ended. But in people who got only the standard shots, Wheatley notes, IgE levels started to claw their way back up once the treatment stopped.

The researchers swabbed participants' noses for clues to why the combo therapy may work. It alters how active some genes in immune cells are, they found. Those genes were related to inflammation. In people who got the combo therapy, those immune cells made less tryptase. That's one of the major chemicals released in an allergic reaction.

The results are encouraging, says Edward Zoratti. But he says it's not clear that this antibody would work as well for other allergies. He wasn't part of this work, but he does study allergies and the immune system at Henry Ford Hospital in Detroit, Mich. He wonders: "Did they just get lucky and choose the right allergen?"

Cat allergies develop mostly against a single sticky antigen. It's a protein known as Fel d1. It's found in cats' saliva and dander. Cockroach allergies, in contrast, can be produced by a variety of proteins. So the combo therapy might not work as well for those allergies.

Also, Zoratti says, the type of antibodies that the new study used (monoclonal antibodies) are pricey. That's another possible drawback.

Much more research is needed before this therapy is added to allergy shots in a doctor's office, he says. But the study is important for understanding how allergy therapies work. And, he adds, "It's one step in a long chain that will probably lead us to a really useful therapy in the future."

— *Tina Hesman Saey*

KDDESIGNPHOTO/SHUTTERSTOCK

STRATEGIES FOR LESSENING EXPOSURE TO CAT ALLERGENS

- Don't pet or kiss cats. If you do, wash your hands and face.
- Keep cats out of the bedroom.
- If you have a cat at home, use a high-efficiency vacuum cleaner regularly to clean the house.
- Bathe cats at least once a week.
- Use a HEPA filter in your heating/cooling system and/or an air purifier with a HEPA filter.
- If you have a severe cat allergy, avoid cats and places where they live.

BIOLOGY

Pokémon 'evolution' looks more like metamorphosis

Change in the natural world is much slower than in the game

The Pokémon games have a simple premise: Kids called Trainers leave home to tame dangerous creatures. The Trainers pit their monsters against each other to make them stronger. Once a Pokémon reaches a certain level or is exposed to a certain item, it can "evolve" and transform into a larger, more powerful form.

The word "evolution," though, may be a bit misleading for what is taking place.

"The biggest issue is that [Pokémon uses] the word 'evolution' to mean metamorphosis, which is completely wrong," says Matan Shelomi. He is an entomologist at National Taiwan University in Taipei City and studies beetles from southern Taiwan. "I guess it's catchy, but it's a real pity they've used that term — especially since so few people understand what evolution actually is."

Evolution describes how species change over time. Natural selection drives these changes. That is, individuals best suited to their environment survive and pass on their genes to their offspring. Genes are responsible for the way organisms look and behave. Over time, more and more individuals gain these useful traits, and the group evolves.

The drastic changes seen in a single Pokémon can give people the wrong impression about how evolution works, Shelomi says. Evolution occurs within populations and species of organisms, not to single organisms. Genetic changes that give rise to new traits must accumulate in a population over many generations. This can happen quickly for organisms that have super short lifespans, such as bacteria. But for things that live longer, like animals, evolution generally takes place over thousands to millions of years.

So that Raichu you got after giving your Pikachu a Thunderstone? "That's not evolution. That's just growth," says Shelomi. "That's just aging."

KAMUI29/SHUTTERSTOCK

LEVELING UP

Pokémon age in a series of steps. Charmander ages to Charmeleon and then to Charizard, for instance. Each step brings changes in color, body shape and size, and ability. This aging process looks a lot like aging in insects and amphibians, says Alex Meinders. This wildlife biologist makes videos about video game ecology on his YouTube channel Geek Ecology.

Consider a monarch butterfly. It didn't start out as a butterfly. It started as a chubby caterpillar that then became a pupa. Finally, that pupa transformed into a beautiful butterfly. This process is called metamorphosis.

Metamorphosis refers to an abrupt, dramatic physical change in an animal's body. Insects, amphibians and some fish experience this as they transition from a larva into an adult. Many insects, like that butterfly, also go through the in-between pupa stage. Each stage looks entirely different from the others. And during the transition, tissues dissolve and form into new body parts.

The evolutions of certain Pokémon, such as the antlion-inspired Trapinch, resemble this type of metamorphosis. "Every stage in a Pokémon is just another metamorphic stage," says Meinders.

PUPAE PHYSICS

Pokémon reach these different stages by fighting. But the last thing caterpillars would want to do is waste energy by brawling. Instead, they spend their time plumping themselves up and storing energy for what's to come. They do this with fat. That fat provides the energy for transforming and developing new body parts, such as wings and reproductive organs. While optional Rare Candies and supplements can help Pokémon evolve, the game creatures don't need food to transform from stage to stage.

"In order to grow, animals have to eat," says Shelomi. "Pokémon seem to put on weight from thin air." And with mass seemingly created from nothing, he notes, "this violates the laws of physics."

Take Mudbray, a mud-horse monster that weighs on average around 110 kilograms (240 pounds). When it transforms into Mudsdale, the monster balloons some 10 times in weight. But in some insect species, Shelomi says, the opposite is true. Larvae are much larger than the adults. Much of the stored energy goes into changing from, say, a fleshy grub to a hard-shelled beetle or that chubby caterpillar into a delicate butterfly. A grub that metamorphoses as fast as a Pokémon would risk harmful changes to its DNA, Shelomi says.

"This all takes some time, and you don't want to rush things," says Shelomi. "If you had to build a building in 20 minutes versus 20 weeks, one of those is going to be much sturdier and better built."

— *Aaron Tremper*

HUMANS

What are allergies?

Sometimes the immune system goes into overdrive

Many things can cause an allergic reaction. Pollen, pet dander, insect bites and stings. Food allergies also are common. For some people, even a tiny bit of peanut or shellfish can cause a potentially life-threatening reaction. Other people are allergic to certain kinds of medicines.

So what causes allergies? Allergens. An allergen is a substance that triggers the immune system to inappropriately go into overdrive. Components of pollen, peanuts — all sorts of things — can be allergens.

It's not the allergens themselves that cause the problem. It's the body's immune system. The immune system's job is to recognize any dangerous substance that gets into the body — then get rid of it. But sometimes the immune system works too well. It can be like a smoke alarm that blares every time you cook a pizza or light a candle. A bit of pollen or a single bee sting tends not to be that dangerous for most people. But for people whose bodies see those as allergens, the immune system goes on red alert. It starts fighting that minor disturbance as if it were a major threat.

The first time a person encounters an allergen, it might not cause a problem. The immune system takes its time learning to recognize the allergen. Then it has to make IgE — short for immunoglobulin E — antibodies to attack it. Antibodies are proteins. They help the body fight off serious threats, such as bacterial or viral infections.

IgE antibodies activate chemicals that produce inflammation in the body. That inflammation triggers the symptoms of allergies. These can run from a stuffy nose and watery eyes to an itchy rash or a throat that threatens to swell closed. How inflammation shows up depends on where in the body that inflammation occurs.

Allergies are common. If you don't have allergies, you probably know someone who does. The American Academy of Allergy, Asthma and Immunology estimates that in the United States alone, more than 50 million people suffer from one or more allergies.

— *Avery Elizabeth Hurt*

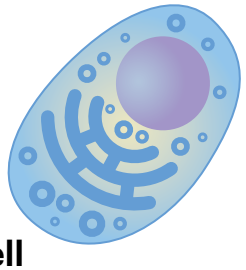
BUDIMIR JEVTIC/SHUTTERSTOCK

How an allergic reaction happens

Stage 1: Initial exposure to allergen

Allergen

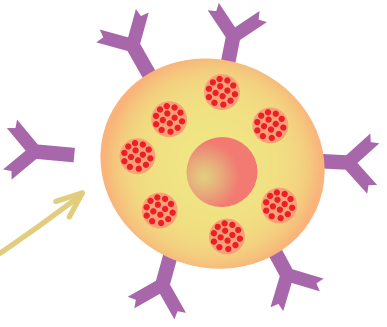
An allergen can be many things. In this case, it's a microscopic bit of pollen from a flower.



B cell

When an allergen gets into the bloodstream, it kicks off a series of events that trigger B cells to make **IgE antibodies**.

IgE antibodies

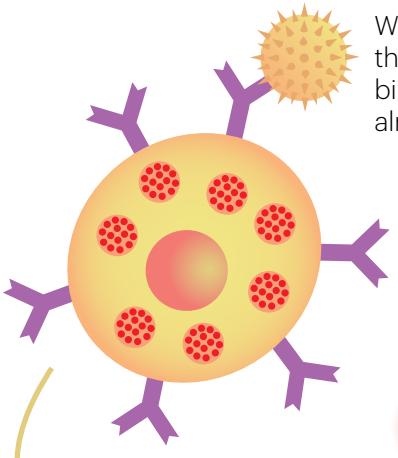


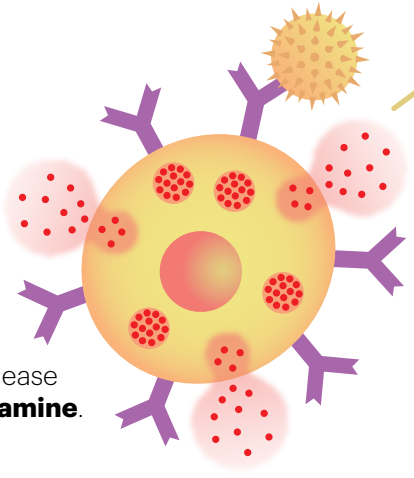
Mast cell

IgE antibodies attach to mast cells, which are then primed to respond if they later encounter the allergen.

Stage 2: Allergic reaction

When the allergen enters the bloodstream again, it binds to the IgE antibodies already on mast cells.





The mast cells then release a chemical called **histamine**.

Histamine triggers **inflammation**, which can result in a runny nose, rash or other symptoms, depending on where in the body this occurs.

ILLUSTRATION BY STEVE MCCRACKEN

EARTH

Salt may suppress lightning at sea

Airborne salt bits may rob clouds of water needed for bolts to strike

Lightning seems to be lacking over the ocean. And sea salt may explain why.

"Most of the lightning occurs over land — the vast majority, more than 90 percent," says Daniel Rosenfeld. A cloud physicist, Rosenfeld works at the Hebrew University of Jerusalem in Israel. His team wondered why lightning was scarcer at sea even though more precipitation falls over the ocean.

One factor that could affect lightning is small particles in the air called aerosols. They provide landing pads for water to condense and form droplets. When droplets rise high into a cloud — where it's colder — the water can freeze into particles and pellets. These ice pieces rub together to create electrical charges that can form lightning.

Over land, aerosols tend to be relatively small. They're usually smaller than 1 micrometer. That's about 100 times smaller than a strand of hair. But at sea, salt spray can fill the air with larger aerosols.

To study the role of aerosols in lightning, Rosenfeld and his team looked at an area that included central Africa and much of the Atlantic Ocean. They used satellite imagery to watch how clouds had developed there between 2013 and 2017. They also compiled data on aerosols in that area and estimated those from sea salt.

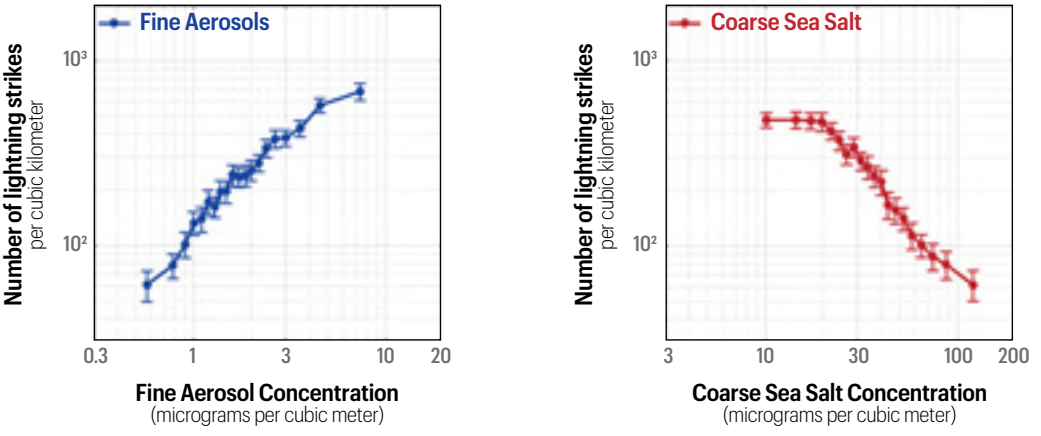
Both over the ocean and over land, an increase in small aerosols was linked to more lightning. That could be because tiny aerosols form small water droplets that can rise high in the air, freeze and make lightning. But an increase in the large aerosols often found over the ocean was linked to less lightning. This may be because hefty sea salt particles cause relatively large drops of water to form. These fall out of the cloud before they can freeze and electrify the cloud.

Understanding how aerosols impact clouds could help make weather predictions and climate models more accurate, Rosenfeld says. He and his colleagues shared their findings in *Nature Communications*.

— *Carolyn Wilke*

AEROSOL EFFECTS

Over an area of the Earth, the researchers watched how cloud systems formed and what factors may contribute to lightning. They investigated how the amount of lightning changed when there were varying amounts of differently sized aerosols in the air. Fine aerosols are smaller than 1 micrometer (left). Coarse sea salt is larger than 1 micrometer (right). These graphs show the lightning density, or the number of strikes per cubic kilometer. Those numbers are adjusted to account for the amount of precipitation in the cloud systems, which is an important factor in forming lightning bolts.



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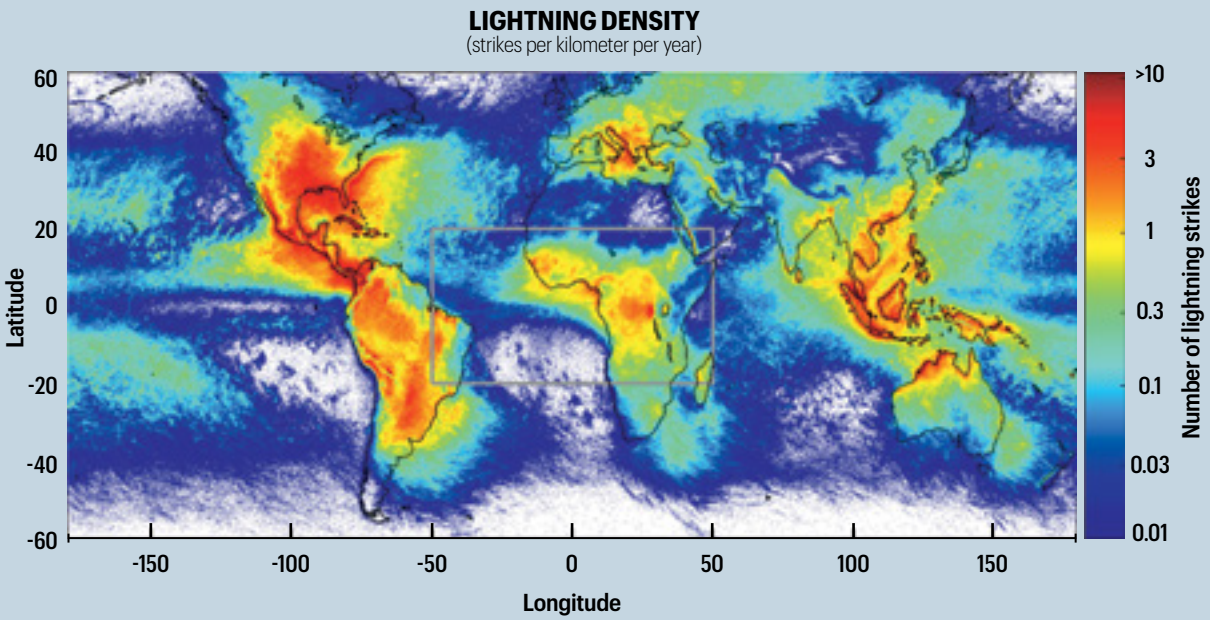
WHERE LIGHTNING STRIKES

Researchers collected data on where and when lightning strikes occurred around the globe. This heat map shows how lightning density varies across the world. The box in the center shows the area where scientists tracked cloud systems.



DATA DIVE

1. Look at the world map. What areas have the highest density of lightning?

2. How does lightning density over land compare with that over the ocean?

3. Look at the pair of graphs. What is the range — or the spread — of values for fine aerosol concentration? How does the density of lightning change with increasing fine aerosol concentration?

4. What is the range of values for coarse sea salt concentration? How does the density of lightning change with increasing aerosol concentration?

5. Compare the trends on the two graphs. Which type of aerosol seems to help lightning form? Which type may hinder lightning?

6. Can you think of other particles in the air that may impact clouds and lightning?

ANSWER

Lice begone!

A wish carved on this ancient comb is the earliest known phonetic sentence

This nearly 4,000-year-old ivory comb bears a simple wish: Get these lice out of my hair!

The faint carving represents the earliest known example of a complete sentence written with a phonetic alphabet. This kind of writing system uses letters or symbols to represent sounds. It later served as a major basis for many modern alphabets.

Yosef Garfinkel calls the comb "the most important object I've ever found during an excavation." He's an archaeologist at the Hebrew University of Jerusalem in Israel. He and his colleagues described it in the *Jerusalem Journal of Archaeology*.

The carving was written in the early language of the Canaanites. This cultural group lived in the eastern Mediterranean region called the Levant.

The comb was unearthed in 2016 among ruins of the ancient city of Lachish, in present-day Israel. Years later, someone noticed faint symbols etched on one side. They spelled out a sentence: "May this tusk root out the lice of the hair and the beard."

It seems to have worked — between the comb's teeth were the ancient remains of a louse.

— *Freda Kreier*

The teeth of this comb hold the remains of an ancient louse.

DAFNA GAZIT/ISRAEL ANTIQUITIES AUTHORITY

INSIDE THE MIND OF A YOUNG SCIENTIST

A finalist of the Regeneron Science Talent Search — Society for Science's most prestigious competition — answers three questions about science

Science competitions can be fun and rewarding. But what goes on in the mind of one of these young scientists? Regeneron Science Talent Search (STS) 2023 finalist Kamisi Adetunji shares some of her science inspiration and advice.

Q What inspired your project?
A "My family is Nigerian," Kamisi says, and sickle cell disease mainly affects people of West African descent. "One day I was on a walk with my mom, and we were talking about a family friend [who] was currently battling sickle cell disease. And she was telling me about all the people back home that she knew who had it or have passed from it." When Kamisi had the opportunity to do research at school, she says, "I immediately knew that I wanted to study sickle cell disease."

Q What was your biggest challenge?
A "The hardest part was definitely the discouragement aspect of it, because I had no prior heavy experience with science projects like this or research in general," Kamisi says. "I had to gain a lot of trust in myself to know that I [would] be able to accomplish this project and to have the tenacity to continue trying different things when things weren't working."

Q Any advice for science project success?
A "If you asked me two years ago if I would be doing this research ... I would have been like, 'What are you talking about? There's no way,'" Kamisi says. "I think the most important thing is to just have that self-belief and trust that you're capable of a lot more than you think you are ... and that your work is worth something and that it's meaningful."

Finalist

Kamisi Adetunji

Kamisi, 17, aimed to improve treatment for sickle cell disease. This genetic condition causes red blood cells to curve, or sickle. That makes it harder for those cells to carry oxygen throughout the body. Natural compounds called flavonoids were known to reduce this sickling. By tweaking the chemical structure of flavonoids extracted from fruits, Kamisi was able to boost their anti-sickling powers. Kamisi attends the North Carolina School of Science and Mathematics in Durham.

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