

The New York Times

For Kids

EDITORS' NOTE: THIS SECTION

SHOULD NOT BE READ BY

GROWN-UPS

DINOSAUR DISCOVERIES
COLOR IN THE LATEST NEWS

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AND HOW DOES IT WORK?

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A 'WRINKLE IN TIME' SPECTACULAR

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MAKE YOUR OWN MARSHMALLOWS
AND RICH HOT COCOA

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LEARN HOW MADISON SQUARE GARDEN
TRANSFORMS BETWEEN EVENTS

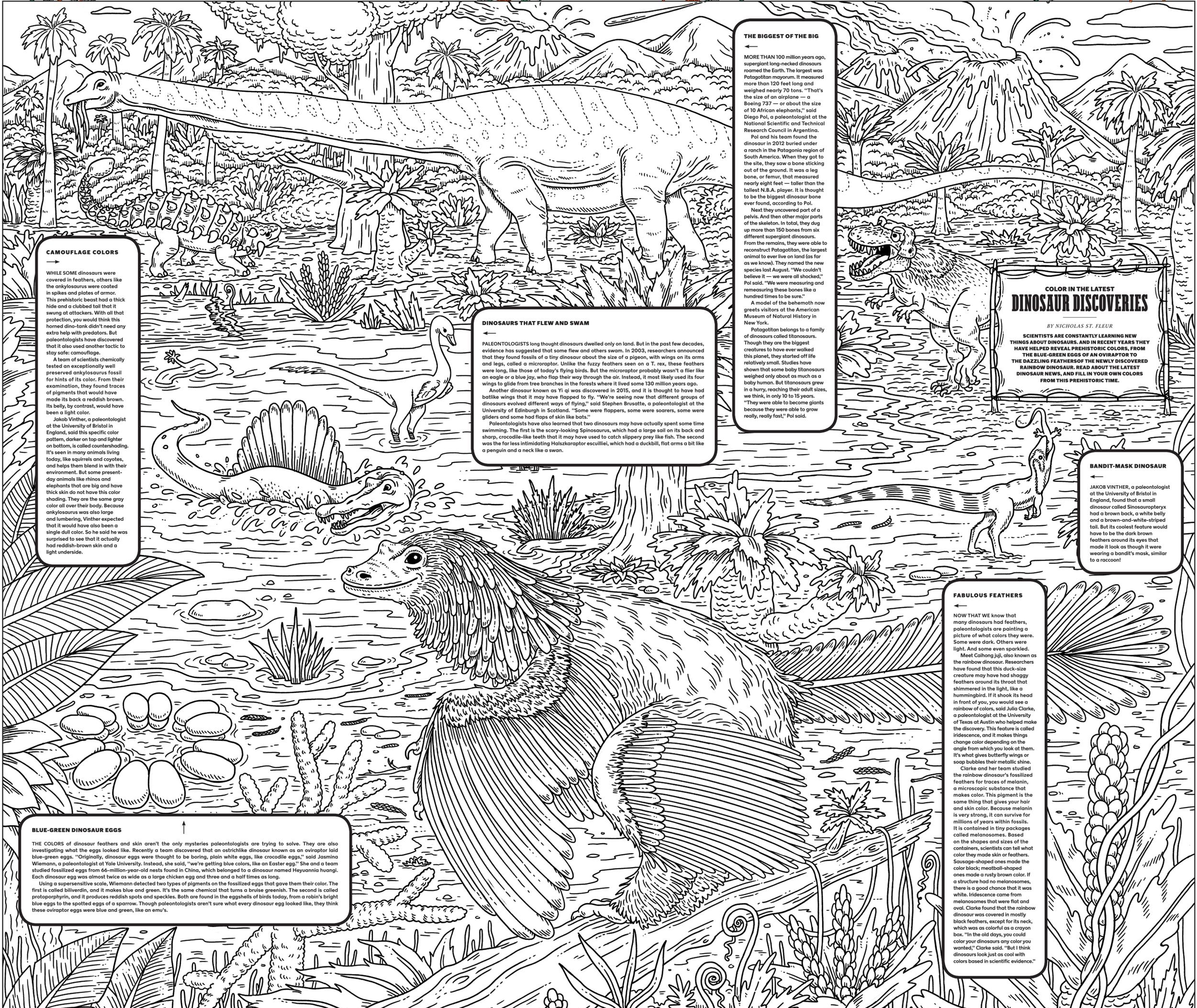
PAGE 10

FUZZY FURY!

HOW PALEONTOLOGISTS ARE REDRAWING T. REX

FORGET WHAT YOU SAW IN "Jurassic World." Tyrannosaurus rex, the fearsome king of the dinosaurs, probably had fuzzy feathers on its body. That's what some paleontologists now think. And though they have yet to find any T. rex fossils with feathers, scientists have redrawn what the prehistoric beast looked like by studying its shaggy cousins. But with a mouthful of nine-inch-long bone-crushing teeth, it was still one of the largest killing machines to have ever walked the planet. "I think it's actually more terrifying to think that T. rex was this 40-foot, seven-ton Big Bird," said Stephen Brusatte, a paleontologist at the University of Edinburgh in Scotland. • T. rex belonged to a group of dinosaurs called theropods. They were mostly carnivores, which means they feasted on flesh. But it's Yutyrannus huali, a 125-million-year-old family member, that has most prompted paleontologists to rethink what T. rex looked like. Discovered in China in 2012, Yutyrannus was covered in small, simple feathers that might have kept it warm or helped it attract a potential mate. It is the strongest evidence so far that T. rex was similarly fluffy. • Not all paleontologists are convinced, though. In 2017, researchers studying fossilized dinosaur skin belonging to T. rex and its close relatives said they found evidence of only scales, not feathers. Perhaps the dinosaur had a mix of both, Brusatte said. But to him, it's clear that the future for T. rex is fuzzy. "I would be willing to stake a pretty large wager that T. rex was feathered," Brusatte said. "Maybe one day someone will prove it." *Nicholas St. Fleur*

ILLUSTRATION BY R. KIKUO JOHNSON



CAMOUFLAGE COLORS

WHILE SOME dinosaurs were covered in feathers, others like the ankylosaurus were coated in spikes and plates of armor. This prehistoric beast had a thick hide and a clubbed tail that it swung at attackers. With all that protection, you would think this horned dino-tank didn't need any extra help with predators. But paleontologists have discovered that it also used another tactic to stay safe: camouflage.

A team of scientists chemically tested an exceptionally well-preserved ankylosaurus fossil for hints of its color. From their examination, they found traces of pigments that would have made its back a reddish brown. Its belly, by contrast, would have been a light color.

Jakob Vinther, a paleontologist at the University of Bristol in England, said this specific color pattern, darker on top and lighter on bottom, is called countershading. It's seen in many animals living today, like squirrels and coyotes, and helps them blend in with their environment. But some present-day animals like rhinos and elephants that are big and have thick skin don't have this color shading. They are the same gray color all over their body. Because ankylosaurus was also large and lumbering, Vinther expected that it would have also been a single dull color. So he said he was surprised to see that it actually had reddish-brown skin and a light underside.

DINOSAURS THAT FLEW AND SWAM

PALEONTOLOGISTS long thought dinosaurs dwelled only on land. But in the past few decades, evidence has suggested that some flew and others swam. In 2003, researchers announced that they found fossils of a tiny dinosaur about the size of a pigeon, with wings on its arms and legs, called a microraptor. Unlike the fuzzy feathers seen on a T. rex, these feathers were long, like those of today's flying birds. But the microraptor probably wasn't a flier like an eagle or a blue jay, who flap their way through the air. Instead, it most likely used its four wings to glide from tree branches in the forests where it lived some 130 million years ago.

Another dinosaur known as Yi qi was discovered in 2015, and it is thought to have had batlike wings that it may have flapped to fly. "We're seeing now that different groups of dinosaurs evolved different ways of flying," said Stephen Brusatte, a paleontologist at the University of Edinburgh in Scotland. "Some were flappers, some were soarers, some were gliders and some had flaps of skin like bats."

Paleontologists have also learned that two dinosaurs may have actually spent some time swimming. The first is the scary-looking Spinosaurus, which had a large sail on its back and sharp, crocodile-like teeth that it may have used to catch slippery prey like fish. The second was the far less intimidating Halszkaraptor escuilliei, which had a duckbill, flat arms a bit like a penguin and a neck like a swan.

THE BIGGEST OF THE BIG

MORE THAN 100 million years ago, supergiant long-necked dinosaurs roamed the Earth. The largest was Patagotitan mayorum. It measured more than 120 feet long and weighed nearly 70 tons. "That's the size of an airplane — a Boeing 737 — or about the size of 10 African elephants," said Diego Pol, a paleontologist at the National Scientific and Technical Research Council in Argentina. Pol and his team found the dinosaur in 2012 buried under a ranch in the Patagonia region of South America. When they got to the site, they saw a bone sticking out of the ground. It was a leg bone, or femur, that measured nearly eight feet — taller than the tallest N.B.A. player. It is thought to be the biggest dinosaur bone ever found, according to Pol.

Next they uncovered part of a pelvis. And then other major parts of the skeleton. In total, they dug up more than 150 bones from six different supergiant dinosaurs. From the remains, they were able to reconstruct Patagotitan, the largest animal to ever live on land (as far as we know). They named the new species last August. "We couldn't believe it — we were all shocked!" Pol said. "We were measuring and remeasuring these bones like a hundred times to be sure."

A model of the behemoth now greets visitors at the American Museum of Natural History in New York.

Patagotitan belongs to a family of dinosaurs called titanosaurs. Though they are the biggest creatures to have ever walked this planet, they started off life relatively small. Studies have shown that some baby titanosaurs weighed only about as much as a baby human. But titanosaurs grew in a hurry, reaching their adult sizes, we think, in only 10 to 15 years. "They were able to become giants because they were able to grow really, really fast," Pol said.

COLOR IN THE LATEST DINOSAUR DISCOVERIES

BY NICHOLAS ST. FLEUR

SCIENTISTS ARE CONSTANTLY LEARNING NEW THINGS ABOUT DINOSAURS. AND IN RECENT YEARS THEY HAVE HELPED REVEAL PREHISTORIC COLORS, FROM THE BLUE-GREEN EGGS OF AN OVIPTOR TO THE DAZZLING FEATHERS OF THE NEWLY DISCOVERED RAINBOW DINOSAUR. READ ABOUT THE LATEST DINOSAUR NEWS, AND FILL IN YOUR OWN COLORS FROM THIS PREHISTORIC TIME.

BANDIT-MASK DINOSAUR

JAKOB VINTHER, a paleontologist at the University of Bristol in England, found that a small dinosaur called Sinusauroraptorx had a brown back, a white belly and a brown-and-white-striped tail. But its coolest feature would have to be the dark brown feathers around its eyes that made it look as though it were wearing a bandit's mask, similar to a raccoon!

FABULOUS FEATHERS

NOW THAT we know that many dinosaurs had feathers, paleontologists are painting a picture of what colors they were. Some were dark. Others were light. And some even sparkled.

Meet Calhoun jiji, also known as the rainbow dinosaur. Researchers have found that this ruck-size creature may have had shaggy feathers around its throat that shimmered in the light, like a hummingbird. If it shook its head in front of you, you would see a rainbow of colors, said Julia Clarke, a paleontologist at the University of Texas at Austin who helped make the discovery. This feature is called iridescence, and it makes things change color depending on the angle from which you look at them. It's what gives butterfly wings or soap bubbles their iridescent shine.

Clarke and her team studied the rainbow dinosaur's fossilized feathers for traces of melanin, a microscopic substance that makes color. This pigment is the same thing that gives your hair and skin color. Because melanin is very strong, it can survive for millions of years within fossils. It is contained in tiny packages called melanosomes. Based on the shapes and sizes of the containers, scientists can tell what color they made skin or feathers. Sausage-shaped ones make the color black; meatball-shaped ones made a rusty brown color. If a structure had no melanosomes, there is a good chance that it was white. Iridescence came from melanosomes that were flat and oval. Clarke found that the rainbow dinosaur was covered in mostly black feathers, except for its neck, which was as colorful as a crayon box. "In the old days, you could color your dinosaurs any color you wanted," Clarke said. "But I think dinosaurs look just as cool with colors based in scientific evidence."

BLUE-GREEN DINOSAUR EGGS

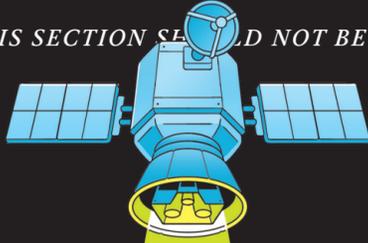
THE COLORS of dinosaur feathers and skin aren't the only mysteries paleontologists are trying to solve. They are also investigating what the eggs looked like. Recently a team discovered that an ostrichlike dinosaur known as an oviraptor laid blue-green eggs. "Originally, dinosaur eggs were thought to be boring, plain white eggs, like crocodile eggs," said Jasmina Wiemann, a paleontologist at Yale University. Instead, she said, "we're getting blue colors, like an Easter egg!" She and a team studied fossilized eggs from 66-million-year-old nests found in China, which belonged to a dinosaur named Heyuannia huangi. Each dinosaur egg was almost twice as wide as a large chicken egg and three and a half times as long.

Using a super-sensitive scale, Wiemann detected two types of pigments that gave them their color. The first is called biliverdin, and it makes blue and green. It's the same chemical that turns a bruise greenish. The second is called protoporphyrin, and it produces reddish spots and speckles. Both are found in the eggshells of birds today, from a robin's bright blue eggs to the spotted eggs of a sparrow. Though paleontologists aren't sure what every dinosaur egg looked like, they think these oviraptor eggs were blue and green, like an emu's.

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**TOTALLY
EXTREME**
SUMMER CAMPS

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WHY
EVERYONE IS
OBSESSED
WITH
FORTNITE

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BLACKOUT
PUERTO RICO STILL
DOESN'T HAVE
FULL POWER

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BEHIND
THE SCENES OF
THE NEW
'STAR WARS'
MOVIE

PAGE 4

HOW THE
INTERNET
KNOWS
EVERYTHING
ABOUT YOU

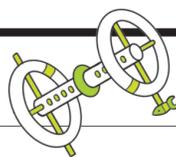
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BEYOND EARTH:
THE THOUSANDS OF OTHER PLANETS IN THE GALAXY.
A NEW NASA SPACE TELESCOPE IS ON THE HUNT FOR ALIEN WORLDS.
*PLUS ASTEROIDS & ROCKETS BOARD GAME!

PAGES 5-7

Science



HOW I BECAME A

NEURO-SURGEON



BY ODETTE HARRIS, M.D.

I WAS BORN in Jamaica, and when I was 8, we moved to New Jersey. In high school, my bus stop was right outside a hospital, and they used to let us wait inside. I was really intrigued, so I started volunteering there and worked as a nurse's assistant in the summers. That, combined with an inclination for the sciences, made becoming a doctor seem like a natural match.

After college, I spent five years in medical school at Stanford University in California. In med school, you take classes and you study, but you also see patients in different kinds of medicine. That's when I discovered I wanted to be a neurosurgeon. Trauma neurosurgeons take care of anybody who has been in an accident and injured their brain or nervous system: people who don't wear helmets when they bike or ski, or who have a bad fall. You rush through the hospital to get people into surgery, and your adrenaline is pumping. The impact is like no other field. Once you've experienced that, there's no going back.

After medical school, I did a seven-year surgery residency, where I worked in a hospital and practiced being a neurosurgeon. I worked a ton of hours, and I didn't sleep much. Now, I'm both a neurosurgeon and a medical-school professor. I operate on people who have problems with their brains; I do research to find better ways to treat patients; and I educate the next generation of neurosurgeons.

It takes a long time to become a neurosurgeon, but this path is fun. Nobody would do something this rigorous if it wasn't. *As told to Elise Craig* ♦

WHO CAN BE A SCIENTIST?

BY HEATHER MURPHY

WHAT DID YOU draw when asked to imagine a scientist on the previous page? A white lab coat? Goggles? A flask filled with bubbling liquid? What about the gender of the scientist? Researchers have been asking kids to draw scientists for more than 50 years as a way to measure the perception of scientists over time — and most draw men.

Recently David Miller, a researcher at Northwestern University, analyzed thousands of "Draw a Scientist" studies from over the years. Even in 2016 — the most recent set he looked at — only about a third of the participating kids drew women. That's partly because we're more likely to see scientists portrayed as men on social media, on TV and in textbooks. "It's like trees having green leaves," says Alice Eagly, a psychologist who also worked on the study. Leaves come in many colors, but we first picture them as green because that's how we commonly see them.

But when we make assumptions about people based on what we're used to seeing or hearing, we can limit them — and ourselves. "What we draw matters," Miller says. "It reflects our automatic associations." If kids are more likely to draw male (or white) scientists, it may mean it's harder for them to see that people of other genders and races can choose that career.

The "Draw a Scientist" results have changed with time: In the 1960s and '70s, less than 1 percent of the kids who participated drew women. That means that alongside more actual women becoming scientists (for instance, there are now more women studying biology at the college level than men), our imaginations have broadened, too. ♦

THE HUNT FOR

ALIEN WORLDS

BY NICHOLAS ST. FLEUR · ILLUSTRATIONS BY SUPER FREAK

SPACECRAFT made by humans have visited Venus and monitored Mercury. They have explored the red sands of Mars and journeyed to the gas giant Jupiter. They've looped through the rings of Saturn and flown by Uranus, Neptune and even the dwarf planet Pluto. But so far, we haven't found life anywhere else. That's not to say we're alone in the universe: Many scientists think life probably does exist out there in the galaxy. So we're on the hunt, using telescopes to look farther and with greater detail into space.

To help accomplish this mission, NASA launched

a refrigerator-size spacecraft into orbit last month that will comb the cosmos for the faraway worlds known as exoplanets. It's called the Transiting Exoplanet Survey Satellite, or TESS for short. "We think there are literally billions of planets out there to be found," says Stephen Rinehart, the TESS project scientist. TESS will look for rocky planets, like Earth, and large gas planets, like Jupiter, that are within about 300 light years of our solar system. That may sound far, but astronomically speaking it's practically next door, and also only a tiny fraction of the entire Milky Way Galaxy, which stretches about

100,000 light years across.

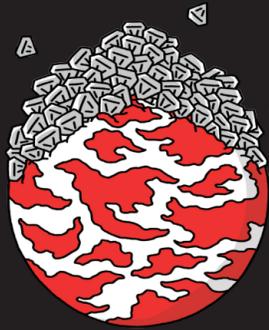
During its search, the space telescope will watch at least 200,000 stars. Because scientists think that every star in the night sky has on average one planet circling it, there could be a treasure trove of new worlds waiting for TESS to discover. And maybe one of them will hold the ingredients necessary for life. The only way to know is to find it.

So far, astronomers have cataloged more than 3,700 exoplanets in our galaxy. Here are a few of the most interesting (and what you'd want to bring if you ventured there). ♦

**SUNSET PLANET**

On Kepler-1647b, sunsets are twice as nice. That's because this planet orbits two stars. It's like the fictional Tatooine, homeworld to Luke Skywalker and Darth Vader in "Star Wars," which had twin suns. Unlike that desert world, Kepler-1647b is a gas giant, so it probably couldn't host any life.

PACKING LIST: Sunglasses, beach towel

**DIAMOND PLANET**

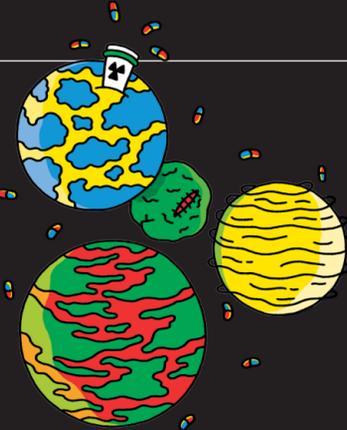
The planet 55 Cancri e may be the planet of bling. Some astronomers think this carbon-rich world is made of diamonds. But not every scientist agrees. Only future studies will tell us how glamorous the planet really is.

PACKING LIST: Pickaxe, hammer, chisel, sack

**WATER WORLD**

Kepler-22b might be a world entirely covered in water. It is about twice the size of Earth and orbits its star in the so-called Goldilocks zone, where things are neither too hot nor too cold. That means it's a contender for being able to support life!

PACKING LIST: Boat, bait, fishing pole

**PULSAR PLANETS**

The ghastly-named planets Drauger, Poltergeist and Phobator orbit a "zombie" star called a pulsar that is the leftovers of a star that exploded. NASA says the pulsar spins once every six milliseconds — faster than you can blink. As it turns, it spews dangerous radiation across its cosmic cemetery.

PACKING LIST: Radiation suit, motion-sickness medicine

**TOO CLOSE FOR COMFORT**

Icarus is a character from Greek mythology famous for flying too close to the sun. Kepler-78b is like his planetary twin, because it orbits extraordinarily close to its star — at a distance of less than a million miles. Even Mercury, our solar system's innermost planet, is some 36 million miles away from the sun.

PACKING LIST: Sunglasses, sunblock, volcano-protection suit

**A GALACTIC GEEZER**

Compared with PSR B1620-26 b, the eight planets in our solar system are mere whippersnappers. It is the oldest planet found so far, clocking in at about 13 billion years old — nearly three times as old as Earth. Nicknamed the Genesis Planet, it formed only about a billion years after the Big Bang.

PACKING LIST: "I Was Here" flag

**RUBY RAINSHOWERS**

Forecast for planet HAT-P-7b: Cloudy with a chance of rubies. The weather on this exoplanet is so wacky it rains gems, like sapphires. Adventurous space pirates will have to travel some 1,000 light-years from Earth if they hope to plunder this treasure planet, though.

PACKING LIST: Umbrella, jewelry box

**PUFFY PLANET**

"It's so fluffy!" That's exactly what Agnes from "Despicable Me" would say if she ever saw the gas giant HAT-P-1b, which scientists say is so light and puffy it could float in water. Even though the exoplanet is wider than Jupiter, it is less dense than cork or balsa wood.

PACKING LIST: Gas mask

**ROGUE PLANETS**

Some planets are rebels. They don't need a star telling them what to do or where to orbit. Known as "rogue planets," they freely float around space unattached to any host stars. Recent research suggests that there may be as many as 75 billion Jupiter-size worlds wandering the cosmos.

PACKING LIST: Flashlight, candles, backup generator (nothing solar-powered)

CHECK OUT THESE EXOPLANETS AND MORE SPACE SCIENCE IN THE GAME ON PAGE 6.

Science

80 FINISHED! You've successfully left the Milky Way Galaxy far behind and traveled 3.8 billion light years from Earth to arrive at the only known extragalactic exoplanets.

79 You venture to the planet Hoth, about 21,000 light years away, but at -370 degrees Fahrenheit it freezes your landing gear.

78

77 You visit the planets Draugr, Poltergeist and Phobetor, but the radiation from their spinning pulsar is too intense.

76

75 You witness two neutron stars colliding. Whoa.

74 You try to spot planet TRES-2b, the darkest planet ever found. It's blacker than coal. But alas, it's too dark for you to see.

73

72 You arrive at the exoplanet KELT-9b, but at 7,500 degrees Fahrenheit, it is the hottest planet ever found and way too hot for you.

71 Next stop, No. 27.

61

62

63

64

65

66

67

68

69

70 MOVE UP TO 71: Oh, no! You're being drawn into the black hole!

60

59

58

57 You go into hypertime and reach the Kepler-90 system some 2,500 light years away, which has eight planets orbiting it — the most of any system found so far, besides our own.

56 You take a spacewalk outside your craft, but you're surprised by a sudden solar flare from a nearby star! You rush inside to avoid the radiation of the incoming particle blast.

55 ROLL AGAIN: You go for an exploratory swim in the giant water world Kepler-22b, nearly 600 light years away.

54

53

52

51

41 A speck of space debris the size of a dime smashes into your spaceship with more force than a hand grenade. You have to get out and make repairs.

42

43

44

45

46

47 You travel past the planet J1407b. Its rings are 200 times larger than Saturn's.

48

49

50

40

39

38 You zoom 40 light years away from our solar system to the Trappist-1 system. You check out its seven Earth-size planets.

37

36 You are almost hit by an interstellar asteroid. Eep!

35

34

33

32

31

21

22 ROLL AGAIN: You send an update of the data you've collected so far back to NASA headquarters to share with the world. Thank you!

23

24

25 LOSE A TURN: Your navigation equipment is damaged, and you must fix it.

26

27

28

29 You forgot to tie down your toothbrush. It floated through the spaceship and hit the controls, knocking you off course.

30

20

19

18 MOVE AHEAD ONE SPACE: You fly by Pluto and snap a photo of its heart-shaped spot.

17

16 LOSE A TURN: Houston, we have a problem. Something is wrong with your ship, so you head back to the International Space Station for a quick checkup.

15 You fly too close to Uranus, and the methane smells too bad for you to handle.

14

13

12 You successfully loop through Saturn's rings.

11

1 START: You suit up and prepare your rocket for takeoff.

2

3

4 The skies in Cape Canaveral, Fla., are clear and blue. You are "go" for launches 3, 2, 1, blast off!

5

6 ROLL AGAIN: You stop at Mars and get a selfie with the Curiosity rover, about 140 million miles away from Earth.

7

8 You easily navigate through the asteroid belt without a scratch.

9

10

ASTEROIDS AND ROCKETS

ILLUSTRATIONS BY GIACOMO GAMBINERI

HOW TO PLAY

Now that you've learned all about TESS and the hunt for exoplanets, it's time to leave Earth behind.

1. TO PLAY THIS GAME (like the classic Chutes & Ladders), you'll need a die and a piece for each player, like a rock or a coin.
2. PLACE ALL THE PIECES ON NO. 1 and pick who's going first.

3. ON YOUR TURN, roll the die and move that many spaces along the board.
4. IF YOU LAND ON A ROCKET (space No. 4, for example), congratulations, your trip is speeding along! Follow the rocket higher on the board.

5. IF YOU LAND ON AN ASTEROID (like No. 15), you've hit a hurdle! Move down the asteroid.
6. ALSO WATCH OUT FOR THE BLACK HOLE on No. 71. If you land there, it will suck you back to No. 27.

7. THE FIRST PLAYER to get to the extragalactic exoplanets on No. 80 wins.
Bon voyage! Let us know if you see any life out there. [Nicholas St. Fleur](#)

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SHARKS: MYSTERIOUS AND MISUNDERSTOOD

AFTER YEARS OF SEEING THEM AS SOLITARY HUMAN-KILLERS, WE ARE FINALLY LEARNING WHAT SHARKS ARE REALLY LIKE. NEW RESEARCH REVEALS THEY'RE SOCIAL, TRAVEL GREAT DISTANCES AND HAVE NO INTEREST IN ATTACKING US.

GIRLS
REVIEW
THE BOY SCOUTS

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WHY YOUR FRIENDS'
PARENTS
ARE COOLER THAN
YOURS

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THE
6 CRAZIEST
WATER PARKS

PAGE 11

NASA GOES
TO THE
SUN

PAGE 5

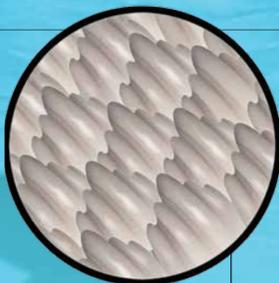
WHY
PIMPLES
ARE IN

PAGE 4

Science

DORSAL FIN

In movies we see this infamous fin sneaking up on unsuspecting swimmers accompanied by suspenseful music. In real life, its purpose is to help stabilize the shark and prevent it from rolling upside down as it glides through the water.



SKIN

Shark skin is covered in tiny scales that make it feel smooth when rubbed in one direction and like sandpaper in the other. The edges of the scales may reduce drag from the water. In the great white's case, the skin also provides camouflage: The top of the shark is gray, and its underside is white. If you look at it from above, it blends in with the water; if you look at it from below, it blends in with the sunlight.

THRESHER SHARKS

This species has tail fins that can be as long as its body. Threshers use them like whips, swinging them at about 20 miles per hour to swat at schools of fish. One good whack can stun multiple fish at once, turning them into easy snacks.

AMPULLAE OF LORENZINI

Sharks have a supersense called electroreception. Speckled across their snouts are jelly-filled pores that can detect tiny electromagnetic signals created by muscle movements. "They can detect the electric fields given off from a beating heart of prey even when it's under the sand," says the marine biologist David Shiffman.

HAMMERHEAD SHARKS

Their unique heads make them the easiest sharks to identify. The strange T shape of their noggins grants them a 360-degree field of vision, wider than any other shark's.

LATERAL LINE

Along with the ampullae of Lorenzini, this sensory organ helps the shark detect movements in the water. As water flows through the lateral line system, which runs from head to tail, it picks up vibrations that tell the shark when prey is nearby.

SWELL SHARKS

They glow in the dark — but only other sharks can see their dazzling disco display. This is a property called bioluminescence, and scientists studying the swell shark recently discovered that these shy predators appear to glow green in the black depths of the ocean, probably to help them find mates.

NOSE

Smell is one of a great white shark's most powerful senses: It can smell tasty seals from two miles away. Its two nostrils, or nares, are used solely to sniff out prey — not to breathe, as they are in humans.

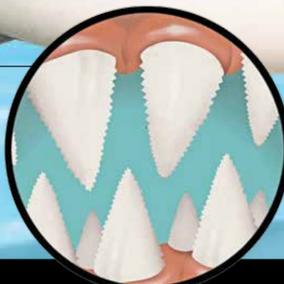
CARTILAGE

Sharks don't have bones the way we do. Instead, their skeletons are made up entirely of cartilage, like your ears and nose. It is much lighter and more flexible than bone, allowing sharks to be nimble swimmers.



TEETH

If one of the two-inch-long teeth lining a great white's jaws falls out, it's no big deal: There's a never-ending supply of razor-sharp replacements right behind it. Over a lifetime, they go through an estimated 30,000.



STOMACH

Sharks can turn their stomachs inside out. Gross! If they are really stressed out or swallow something they can't digest, they literally puke their guts out through their mouth — and then suck their stomach back in.

JAW

Sharks' jaws aren't attached to their skulls, so they can push out their mouths to take bigger bites.

GILLS

As they swim, great whites breathe through their gills, which absorb oxygen from the water. Unlike nurse sharks and bullhead sharks, great whites don't have strong muscles in their cheeks that can pump water into their bodies, so if they stop swimming, they can die from a lack of oxygen.

LIVER

Great white sharks have enormous livers that can be a quarter of their entire body weight. Their livers store large amounts of fatty oil that can act as a fuel source for long journeys. Because the fatty oil is lighter than water, the liver is the key to helping sharks float.

LISTEN, we won't disagree with you: The big, toothy grin of a shark is frightening. But there's nothing to be afraid of! For all the shark drama you see on television shows, in movies and in the local news, much of their reputation as solitary, bloodthirsty, human-hunting villains is just wrong. Because they are so elusive, it was once easy to imagine them this way, but scientists have learned more about them lately.

"Sharks are not the mindless killing machines that people used to think that they were," says David Shiffman, a marine biologist at Simon Fraser University in Vancouver. "They are capable of some really complicated activities like social interactions, problem-solving and making enormous migrations." The 1975 movie "Jaws" played an outsized role in the public's imagination. In it, there's one type of shark, a great white, and

one type of behavior: chomping people. Scientists have always known that devouring humans wasn't the defining characteristic of sharks — not to mention that there are at least 500 species, with many different types of behavior — but now, thanks to years of dedicated research and improved tracking techniques, we can see them as they really are. "Scientists are smashing the misconception that all sharks are loners," says Melissa Márquez,

a marine biologist and founder of the Fins United Initiative. "In fact, many species do like to be around others of their kind — for example, scalloped hammerheads, sand tiger sharks, leopard sharks, white-tips and whale sharks." And if you're not convinced yet, consider this statistic: Sharks kill five to 10 humans per year around the world, whereas humans kill an estimated 100 million sharks per year. So, really, we're the scary ones.

HOW TO FIND A SHARK

TRACKING TAGS:

Where do sharks hang out? High-tech tags attached to the body of great whites have started to show us. For instance, researchers tagged more than 70 great white sharks and observed them via satellite. They found that every year, the sharks would swim more than 1,000 miles to a seemingly empty spot in the Pacific Ocean

MONSTERS NO MORE

BY NICHOLAS ST. FLEUR
ILLUSTRATIONS BY BILL MAYER

halfway between Mexico and Hawaii. Now known as the White Shark Cafe, the area is about as large as Colorado. Marine biologists didn't have a clue why or how many sharks in total made the long trip, so in April they visited the cafe on a research vessel. They discovered a smorgasbord of marine life, like plankton, squid and tuna. "We thought this was a remote ocean desert," says Barbara Block, a marine biologist from Stanford University

who led the research project. "But we now know the place the sharks took us to was like an oasis in the desert." Block says her team is still not sure whether the sharks travel to the cafe so they can eat, mate or both, but it's really cool that they come together like this. "By putting tags on big animals, we are learning their secrets in the ocean," Block says. "But there are still a few mysteries we don't have figured out."

SHARK POOP:

Since sharks are so hard to find, some scientists have begun tracking them using an even slier sign of their whereabouts: their poop. Well, it's technically called "environmental DNA," but it's basically the body waste, mucus, saliva and shed skin cells that marine animals like sharks leave behind. "From small plankton to big whales, all of their DNA is floating around in the water," says Judith Bakker, a marine biologist

at Florida International University, who is searching the seas for these clues. This technique allows scientists to collect data on shark populations without having to catch any sharks. They drop special tubes into the water from a boat or while scuba diving. They then analyze all the DNA in the

water — first separating shark DNA from other marine-animal DNA and then identifying the species. The research has already been used to confirm the presence of whale sharks in the Persian Gulf, estimate rare Greenland shark populations in their home waters and detect great hammerhead sharks in the Caribbean and New Caledonia. A major goal of the work is to pinpoint where endangered sharks exist to better protect them. Thanks, poop! ♦

The New York Times

FOR KIDS

EDITORS' NOTE: THIS SECTION SHOULD NOT BE READ BY GROWN-UPS



HOW TO FIND A LOST PET
PAGE 5

THE BEST EXCUSES OF ALL TIME
PAGE 3

THE EPIPEN CRISIS
PAGE 11

WHAT'S UP WITH MEMES
PAGE 2

WHAT HAPPENED TO TOYS 'R' US
PAGE 11

ANDROMEDA
This princess was chained to a boulder, about to be sacrificed to a sea monster, when she was saved by the Greek hero Perseus. Inside this constellation lies the Andromeda Galaxy, which at more than 2 million light years away is the closest galactic neighbor to our Milky Way.

ARIES
One of the zodiac constellations. In Greek mythology, a hero named Jason and his crew, the Argonauts, quested to retrieve the Golden Fleece, the coat of wool of this flying golden ram.

CAMELOPARDALIS
Before they were called giraffes, these animals were known as "camel-leopards" because of their spots. A Dutch astronomer named Petrus Plancius introduced this constellation in the early 1600s.

CETUS
This huge creature, often depicted as a whale, giant fish or sea monster, was about to devour the princess Andromeda before Perseus killed it and saved her. True to its name, Cetus is one of the largest constellations.

CYGNUS
Flying overhead, this swan is a relatively easy constellation to spot. In mythology, the Greek god Zeus once transformed into a swan to woo a woman named Leda.

DRACO
Known as Ladon in Greek mythology, this dragon, with a coiling, snake-like body, guarded a golden apple in a sacred garden. It met its demise when Hercules shot it with an arrow and stole the fruit.

YOUR ULTIMATE STARGAZING GUIDE

BY NICHOLAS ST. FLEUR
ILLUSTRATIONS BY FRANCESCO MUZZI

HUMANS HAVE gazed up at the stars for eons. The twinkling lights have helped sailors navigate the seas, farmers plan their harvests and ancient storytellers imagine tales of triumph and sorrow. We call our interpretations of the way they are arranged in the night sky constellations. "Constellations were the original ultimate night out, like your movie theater," says Jackie Faherty, an astrophysicist at the Hayden Planetarium at the American Museum of Natural History in New York.

To the ancient Greeks and Romans, the constellations told of heroes like Perseus, who saved the beautiful Andromeda from being eaten by the sea monster Cetus. Throughout time, cultures like the Chinese, the Babylonians, the Egyptians, the Inuit, the Australian Aboriginals and many others across the world have bestowed different names upon the constellations. Though these early astronomers may have used the same stars, they often connected the dots differently. What the ancient Greeks saw as a mighty hunter named Orion, a Chinook tribe in North America saw as two canoes racing the Big River, or Milky Way. You might be most familiar with the so-called zodiac constellations, like Aries, Leo or Gemini, which are used in astrology. (Although fun, astrology is not astronomy, and it is not a science.)

Today there are 88 official constellations recognized by the International Astronomical Union. Depending on where you live, you'll observe different ones in the night sky: Cassiopeia in the Northern Hemisphere, but the Southern Cross in the Southern Hemisphere. And remember, although the stars in a certain constellation may look close together, in reality they are very far from one another. We're talking dozens, even hundreds of light-years. In total, our galaxy, the Milky Way, contains a mind-boggling number of stars — a space telescope recently surveyed nearly 1.7 billion, and scientists think that only accounts for 1 percent of them. Makes Earth seem pretty small, doesn't it?

HERCULES
The most famous hero in Greek mythology, Hercules (who was called Hercules by the Romans) was the son of Zeus and a man of unmatched strength who won many battles against the fiercest of monsters. Several of the beasts he slew can be found in the stars: the many-headed Hydra, the crab, Cancer; and the lion, Leo.

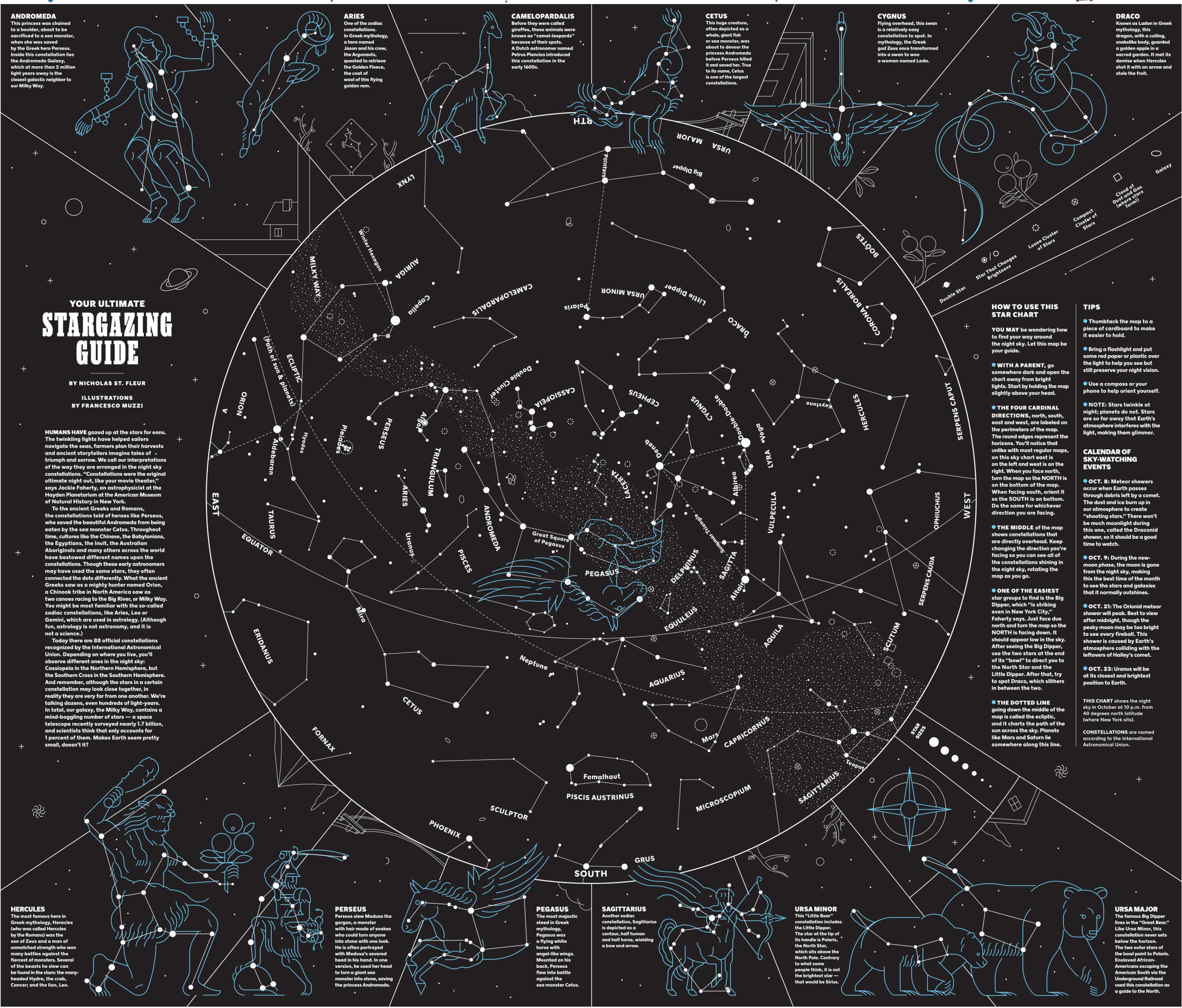
PERSEUS
Perseus slew Medusa the gorgon, a monster with hair made of snakes who could turn anyone into stone with one look. He is often portrayed with Medusa's severed head in his hand. In one version, he used her head to turn a giant sea monster into stone, saving the princess Andromeda.

PEGASUS
The most majestic steed in Greek mythology, Pegasus was a flying white horse with angel-like wings. Mounted on his back, Perseus flew into battle against the sea monster Cetus.

SAGITTARIUS
Another zodiac constellation, Sagittarius is depicted as a centaur, half human and half horse, wielding a bow and arrow.

URSA MINOR
This "Little Bear" constellation includes the Little Dipper. The star at the tip of its handle is Polaris, the North Star, which sits above the North Pole. Contrary to what some people think, it is not the brightest star — that would be Sirius.

URSA MAJOR
The famous Big Dipper lives in the "Great Bear." Like Ursa Minor, this constellation never sets below the horizon. The two outer stars of the bowl point to Polaris. Enslaved African-Americans escaping the American South via the Underground Railroad used this constellation as a guide to the North.



HOW TO USE THIS STAR CHART

YOU MAY be wondering how to find your way around the night sky. Let this map be your guide.

WITH A PARENT, go somewhere dark and open the chart away from bright lights. Start by holding the map slightly above your head.

THE FOUR CARDINAL DIRECTIONS, north, south, east and west, are labeled on the perimeters of the map. The round edges represent the horizons. You'll notice that unlike with most regular maps, on this sky chart east is on the left and west is on the right. When you face north, turn the map so the NORTH is on the bottom of the map. When facing south, orient it so the SOUTH is on the bottom. Do the same for whichever direction you are facing.

THE MIDDLE of the map shows constellations that are directly overhead. Keep changing the direction you're facing so you can see all of the constellations shining in the night sky, rotating the map as you go.

ONE OF THE EASIEST star groups to find is the Big Dipper, which "is striking even in New York City," Faherty says. Just face due north and turn the map so the NORTH is facing down. It should appear low in the sky. After seeing the Big Dipper, use the two stars at the end of its "bowl" to direct you to the North Star and the Little Dipper. After that, try to spot Draco, which slithers in between the two.

THE DOTTED LINE going down the middle of the map is called the ecliptic, and it charts the path of the sun across the sky. Planets like Mars and Saturn lie somewhere along this line.

TIPS

● Thumbtack the map to a piece of cardboard to make it easier to hold.

● Bring a flashlight and put some red paper or plastic over the light to help you see but still preserve your night vision.

● Use a compass or your phone to help orient yourself.

● NOTE: Stars twinkle at night; planets do not. Stars are so far away that Earth's atmosphere interferes with the light, making them glimmer.

CALENDAR OF SKY-WATCHING EVENTS

● **OCT. 8:** Meteor showers occur when Earth passes through debris left by a comet. The dust and ice burn up in our atmosphere to create "shooting stars." There won't be much moonlight during this one, called the Draconid shower, so it should be a good time to watch.

● **OCT. 9:** During the new-moon phase, the moon is gone from the night sky, making this the best time of the month to see the stars and galaxies that it normally outshines.

● **OCT. 21:** The Orionid meteor shower will peak. Best to view after midnight, though the pesky moon may be too bright to see every fireball. This shower is caused by Earth's atmosphere colliding with the leftovers of Halley's comet.

● **OCT. 23:** Uranus will be at its closest and brightest position to Earth.

THIS CHART shows the night sky in October at 10 p.m. from 40 degrees north latitude (where New York sits).

CONSTELLATIONS are named according to the International Astronomical Union.

FROM THE NEW YORK TIMES MAGAZINE

The New York Times For Kids

EDITORS' NOTE: THIS SECTION SHOULD NOT BE READ BY GROWN-UPS

THE HEART

KNOW ITS NAME

The heart is the hardest-working organ in the body. Every cell, from the neurons firing in our brains to the vessels in the tips of our toes, depends on blood surging from this mighty muscle to grow and function. If it stops working, you typically only have a few minutes before the rest of your body begins to shut down and you're a goner!

THE ROYAL CHAMBERS

The heart has four chambers that contract and relax, pumping blood through a network of arteries and veins called the circulatory system. The upper chambers are called atria, and the lower ones are ventricles.

WHEEEEEEEE!

As blood travels through your circulatory system, it delivers oxygen and nutrients throughout your body. Blood cells that have dropped off their oxygen enter the right side of the heart in order to refuel. There, the heart pumps the blood into the lungs, where it picks up oxygen. After being replenished, the red blood cells turn bright red and enter the left side of the heart, where they are pumped back to the rest of the body to keep everything going.

LUB-DUB, LUB-DUB, LUB-DUB

That's the sound of a healthy heart beating. Doctors listen for this simple rhythm when they place a stethoscope on your chest during a checkup. It tells them if blood is properly pumping through your body. The actual sound is made by the valves between heart chambers snapping shut.

PLAYING THE LONG GAME

Your heart never stops beating. Every minute, it beats between 70 and 110 times. If you're 10 years old, your heart has already beat more than 450 million times; over the course of your lifetime, it will beat more than 2.5 billion times.

A MIND OF ITS OWN

Think about this: You don't have to "think" to make your heart beat. That's because your heart has its own electrical system that controls when its chambers contract and pump. It does that job automatically — no brain necessary.

MEASURING GREATNESS

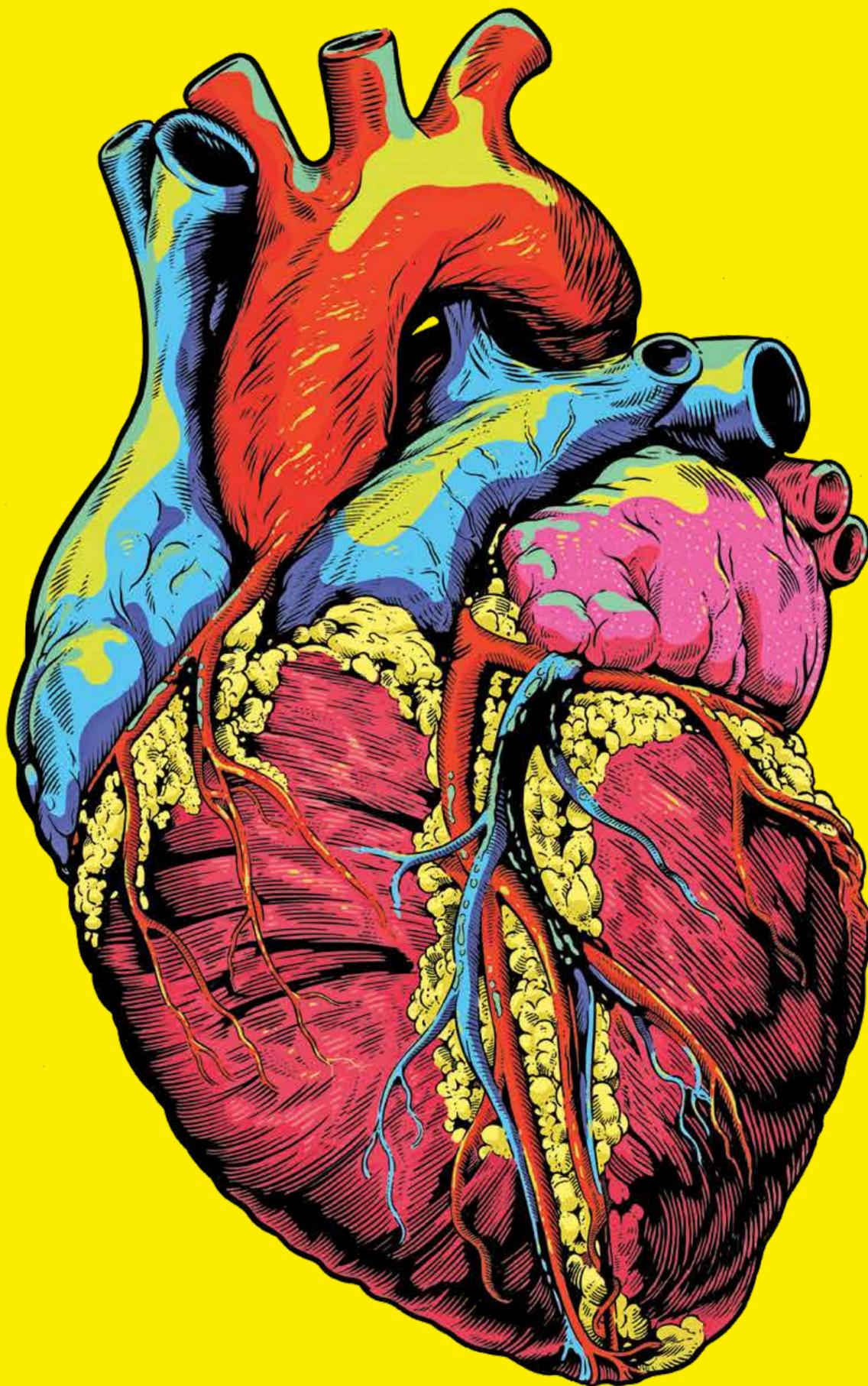
Clench your hand into a fist. That's about the size of your heart. It will grow larger as you do.

BLOOD, EVERYWHERE

Every day, a full-grown heart pumps about 2,000 gallons of blood. That's almost 4,000 two-liter soda bottles' worth of fluid.

THE BODY ISSUE

TAKE A PEEK BENEATH YOUR SKIN IN THIS SPECIAL HOW-IT-WORKS SECTION. BONES, BLOOD, BURPS — WE'VE GOT IT ALL.



Science

WHY DO WE LIKE BEING SCARED?



BY SUSAN COSIER

WHEN YOU HEAR the creak of the basement stairs while you thought no one was home, or you see a flash of something that creeped you out in the past, like a circus clown, you might get goose bumps or feel panic rising. Yep, you're afraid: Your body has released chemicals that make your heart pound, your skin sweat and your eyes dilate. It's a biological response known as "fight or flight," and it takes place to give you the energy and concentration needed to either attack the threat or run away. "Your body becomes like a superhero, and you may feel energized," says Margee Kerr, a sociologist who studies fear at the University of Pittsburgh.

Surprisingly, those fear reactions can also make us feel good, because they put us intensely in the moment, or because we enjoy the surge of energy. That's especially the case if we have some control over the situation and aren't in any real danger, and it's why we watch scary movies or visit haunted houses. As an added bonus, once we watch the credits roll or make it out of the haunted house alive, we often feel braver and more relaxed than before. Some people like being terrified by horror films or roller coasters more than others — that comes down to our DNA and our past experiences — but almost everyone likes some kind of thrill. Mua-ha-ha, biology! ♦



BACK FROM

THE DEAD

EXTINCT ANIMALS COULD WALK THE EARTH AGAIN — HERE'S HOW SCIENTISTS WOULD DO IT

BY NICHOLAS ST. FLEUR • ILLUSTRATION BY JON MACNAIR



EXTINCTION IS THE ultimate grim reaper. From the ferocious Tyrannosaurus rex to the clueless dodo bird, more than 99 percent of animal species that have ever lived on Earth have fallen victim to it. But some scientists are working on ways to bring lost species back from the dead. It's a process called "de-extinction." No, we're not talking about making zombies — more like Frankenstein's monster. But rather than sewing a bunch of body parts together to create a new creature, scientists are trying to build animal hybrids by editing the genetic code of a living species so that it matches that of an extinct one. "De-extinction is reinvention," says Ross MacPhee, a mammalogist from the American Museum of Natural History in New York.

One popular candidate for resurrection is the mighty woolly mammoth. These bulky ice-age beasts disappeared some 4,000 years ago. But because researchers have found woolly-mammoth

bones with well-preserved DNA, the scientists can use that ancient blueprint to alter a living relative, the Asian elephant. "We're mutating the cells of an Asian elephant so they have the exact DNA sequence of the mammoth," says George Church, a geneticist at Harvard University.

Church and his team have so far brought back and tested three genes in an Asian elephant that could make it more resistant to cold temperatures. One day, they could potentially engineer the elephant's genome so that it is born with a fur coat, smaller ears and a thicker layer of fat. Even then, though, the end result wouldn't be a woolly mammoth circa 45,000 B.C. but an animal that is part Asian elephant and part woolly mammoth.

There are many ethical issues with bringing a long-lost species back into a world that no longer has a place for it. Instead, some scientists say, a better use for this technology might be to preserve endangered animals, like the black-footed ferret or the northern white rhino, or to revive species that suffered a recent demise, like the gastric-brooding frog. Maybe extinction isn't a death sentence after all. ♦



MONSTERS THAT LIVE ON YOU

BY AMBER WILLIAMS



DON'T LOOK NOW, but there are mites living on your face. Eight-legged face mites eat, give birth to babies and die right there on your cheek. Almost everyone has them. Take a deep breath: You've just brought hundreds or thousands of species of microbes into your lungs. Sit down: You can't see it, but now you're surrounded by "a floating, leaping, crawling circus" of microscopic life, writes the ecologist Rob Dunn in his book "Never Home Alone."

Dunn and his team at North Carolina State University study the bacteria, fungi and insects that hang out in your home, and there are lots of them: As many as 200,000 species are your roommates! To find out what's hiding in your carpet, shower head or cabinets, the researchers look for bugs and take swabs (using Q-tips) of dust. "We search the house, like we would at a rain-forest site, looking at each habitat: saltshakers, refrigerators, basements, washing machines, kitty litter," Dunn says. They then analyze the DNA in the samples and catalog what critters they've found, including bedbugs (shown above), book lice, gnats, house centipedes, cellar spiders and much, much more. All of these things look absolutely horrifying when magnified under a microscope, but most of them aren't bad — and may even be helpful. For instance, human skin flakes off at a rate of about 50 million flakes a day. There are thousands of bacteria riding on and eating each flake, and those bacteria feed fungi, which feed dust mites, which feed leopard mites, which feed bigger things. "There's a whole food web associated with you falling apart," Dunn says. All of this keeps your dead skin from piling up. It's kind of gross but, hey, so are humans. ♦



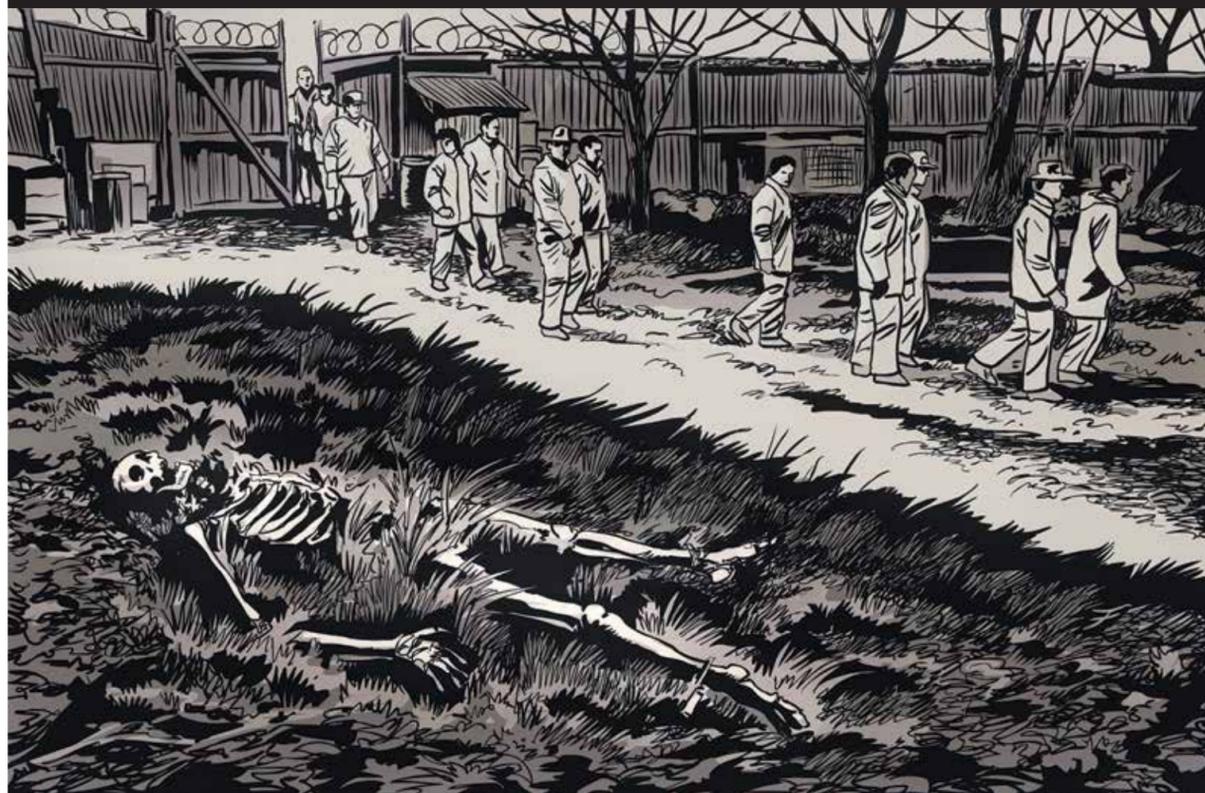
ATTACK OF THE GIANT BUGS!

So now you know you have mites on your face, but do you know what those little monsters actually look like? Have you seen the mouth of a bedbug? The spikes on a flu virus that help it hold on inside your nose? Ever wanted to be face to face with a hairy cockroach? We've created an augmented reality experience just for you, so that you can see these bugs and more, blown up larger than life and appearing right in your own room! Here's how:

1. Open the camera or QR reader in your smartphone (or a grown-up's phone).
2. Point the camera at the code box above. You don't need to take a photograph — just focus on it.
3. Touch the pop-up bubble that says "Open 'nytimes.com' link."
4. Your phone will then take you to the NYTimes app. If you don't have the app, it will open your web browser, which will give instructions for downloading the app.
5. Once you're in the app experience, you'll see bugs! Follow the onscreen instructions to make these microscopic monsters the size of a refrigerator and move around your room!
6. If you want to use a computer to see these monsters up close and personal, visit nytimes.com/monsters.

WELCOME TO THE BODY FARM

BY CHELSEA LEU • ILLUSTRATION BY FRANCESCO FRANCAVILLA



THERE'S A CERTAIN plot of land in Knoxville, Tenn. It's nearly three acres of forest on a bluff overlooking a river, and the whole area is littered with decaying human bodies. Some of them are buried. Others are lying out on the ground. And a lot of them are crawling with maggots. It's known as the Body Farm.

It sounds like the perfect setting for a horror movie — and also for science. The Body Farm is technically called the Anthropology Research Facility at the University of Tennessee Knoxville, and scientists put the corpses out there on purpose to study how dead bodies decompose, or break down. Detectives at law-enforcement agencies rely on this kind of research, known as forensic anthropology, to help them figure out when and how a person died. Depending on where a body is (under the dirt, lying on the grass) and what

the weather is like, the body will turn to ooze and bone at different rates — and someone has to figure out the effects of these factors.

When did a person breathe one last breath? Scientists can estimate by studying the insects that show up on the scene. "As soon as an individual dies, their chemistry changes, and that chemistry is attractive to female flies," says Dawnie Steadman, a skeletal biologist at the facility. If it's warm out, the flies lay eggs on the body within hours after death, which hatch into maggots that then feed on the flesh a few days later before they leave. Beetles arrive afterward, when the body dries out, since they prefer to eat harder tissue like dried skin and cartilage. Depending on which creepy-crawlies are there and whether they're babies or adults, scientists can work backward to estimate how long the

body has been lying outside.

Researchers also estimate the time of death by seeing how much of the body has been consumed by bacteria. Part of the reason dead bodies look bloated, Steadman says, is that they're filled with gas from those microbes. That gas is filled with smelly chemicals with names like putrescine and cadaverine, which give corpses the strong, unmistakable scent of decay. Scientists might also investigate isotopes — different forms of elements — in hair, teeth, fingernails and bone, which can give clues to where people grew up and where they have lived.

Ultimately, all this research helps identify missing people, which is why 4,000 "pre-donors" have signed up to give their own bodies to the Body Farm when they die to help solve cases faster in the future. ♦

SCARY BUT TRUE



"GIANT SPIDERS' WEB COVERS GREEK BEACH"

GUARDIAN SEPT. 20, 2018

"AUSTRALIAN RESEARCHERS HAVE JUST DETECTED MYSTERIOUS RADIO SIGNALS FROM DEEP SPACE"

BUSINESS INSIDER AUSTRALIA OCT. 11, 2018

"SCIENTISTS IDENTIFY 'MUMMY JUICE' IN EGYPTIAN SARCOPHAGUS"

NEW YORK POST JULY 23, 2018

"VENOMOUS SEA CREATURES ON THE RISE THANKS TO CLIMATE CHANGE"

NATIONAL GEOGRAPHIC OCT. 8, 2018



MY SCARIEST MOMENT



Santiago Orellana, age 10

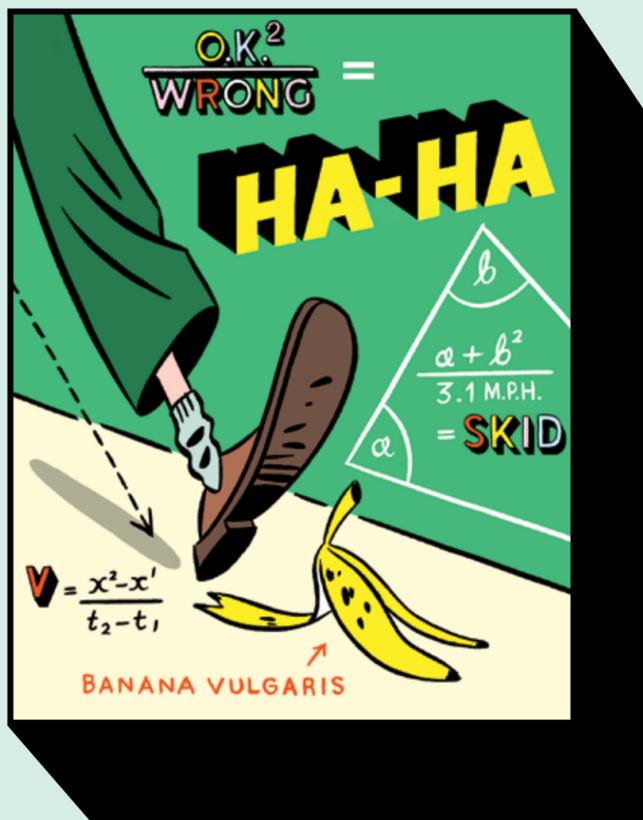
When I was about 7, I was scared of everything, especially ghosts. Once, my brother was in our living room, and he saw a little girl come into our apartment. He thought she was real, but he checked, and the door was locked. We've had three apartments, but he told me that she followed us when we moved. One day, I was watching TV when I felt something tug on the back of my shirt behind my neck. I thought my dad had played a trick on me, but he wasn't there. I thought about the little girl, but it couldn't have been her. The tug was too strong. It was something paranormal: an older-man ghost. My sister told me that ghosts don't try to kill you — they just try to mess around with you. And that's what he did. ♦

Science

THE SCIENCE OF

HUMOR

BY KELLY CONABOY · ILLUSTRATION BY JASON FORD



WHY IS IT that sometimes when you tell your friend a very funny joke — like about his body odor — that friend doesn't laugh? Is it jealousy? Or could it be some sort of ... science-related reason?

What makes something funny has been a question pondered by thinkers since humans had butts. The ancient Greek philosophers Plato and Aristotle believed humor came about when someone was made to feel superior to another person; the super-famous psychiatrist Sigmund Freud thought funniness arose from the mention of unmentionable things. The popular theory until recently was that a joke got laughs when something surprising happened, like — just for example — a cat completing a (purr-fect) pirouette.

These theories help to explain both what makes something funny and the social purpose of humor: It's used to bond groups, and to make scary things less scary. It also allows kids and adults alike to be creative and silly. But each of these ideas had some humor holes — something could be surprising, for example, but not prompt a laugh. (BOO! See?)

The newest accepted theory, called the "benign violation theory" by scientists, claims that to be funny something has to be wrong in an unexpected way (a violation) but ultimately O.K. (benign). The idea arose from studies done by Peter McGraw and Caleb Warren at the University of Colorado at Boulder's Humor Research Lab — a group experimenting not on rubber chickens and whoopee cushions but instead on whether its subjects find one joke funnier than a slightly different version of the same joke. Hilarious! Their studies found that people laugh the most when something seems weird, wrong or surprising, but turns out to be fine. For example, if your friend slips on a banana peel and gets hurt, that's just wrong. But if she slips on a banana peel and is fine, well — that's just funny.

"What's useful about this idea," McGraw says, "is that it explains why not everybody finds your joke funny, even if you do." That is, what might be wrong-but-O.K. to you might just be wrong, or just O.K., to someone else. If it doesn't achieve both things, your joke becomes either rude or boring — explaining why your friend might not find that body-odor joke funny. Luckily, there's always experimentation; maybe he'd prefer a joke about his unfortunate haircut? ♦

SILLY SCIENCE FOR THE WIN

BY CHELSEA LEU

THE NOBEL PRIZE is serious. Winning one means you've contributed something invaluable to the world. You're given a gold medal, hundreds of thousands of dollars and, best of all, everlasting glory. The Ig Nobel Prizes are ... not those prizes. They're awarded every year to the weirdest research — including published papers with titles like "Why Do Old Men Have Big Ears?" Winners receive a handmade trophy and 10 trillion Zimbabwean dollars (worth pretty much nothing). Yes, this is still real research! But this time, you're allowed to laugh at it. Here are three recent honorees.

KIDNEY STONES AND ROLLER COASTERS



Having kidney stones is horrible. They're tiny, scratchy pebbles that develop in the kidney and need to be peed out. Ouch. Last year, two doctors from Michigan State University won the Ig Nobel Prize in Medicine by discovering a method to help shake them out: a roller-coaster ride. The doctors made a fake kidney and filled it with kidney stones (taken from an overjoyed patient) and pee (from a researcher). They put the whole contraption in a backpack and took a trip to Walt Disney World, where they rode the Big Thunder Mountain Railroad roller coaster 20 times in one day. "It ceases to be fun pretty darn quick," says David Wartinger, one of the researchers. The ride, though, did help coax out kidney stones, especially when researchers sat in the last few cars. "You're looking for a rough, quick coaster," Wartinger says. "One that knocks your fillings loose." Whee!

CROCODILES AND SLOT MACHINES



Do your emotions affect how daring you are? Yup — especially if that emotion is fear. Two psychologists in Australia, winners of the Ig Nobel in Economics in 2017, gave \$20 to more than 100 tourists before or after they held a roughly three-foot-long saltwater crocodile. Then they asked them to use that money on a virtual slot machine. It turns out that holding a crocodile makes you less likely to take risks: Most people without gambling problems made smaller bets afterward, possibly because animals that could rip your fingers off remind you to be more cautious.

DIDGERIDOOS AND SNORING



The didgeridoo is an extremely long wind instrument traditionally played by Aboriginal Australians with astonishing breath control. Obviously it can help with snoring. Right? Researchers gave didgeridoos to 14 very loud snorers in Switzerland, who took lessons on how to play. To measure later whether they were snoring less, the researchers asked the patients' partners how well they slept. (The ratings included "not disturbed at all" and "very, very severely disturbed.") "Regular didgeridoo playing is an effective treatment alternative," the scientists concluded — and for that, they won the Ig Nobel Peace Prize. ♦

SPACE IS

BY NICHOLAS ST. FLEUR
ILLUSTRATION BY MARK MATCHO

ASTRONAUTS HAVE ONE of the best jobs in the world. They get to fly into space and, aboard the International Space Station, ooh and ahh at our beautiful planet from 250 miles away. Yes, their view from up there is literally out of this world, but there's a hiccup: No matter how far humans venture from Earth, we can't escape our biology. We get hungry, and itchy, and we need to poop. These human foibles make for some funny space stories.

WHEN MICROGRAVITY ISN'T FUN

Astronauts face tiny challenges every day. Like having to poop. In zero gravity, you don't really "sit" to go No. 2. Instead, you point your rear end above a tiny aluminum toilet equipped with a suction fan, and then you catch your poop in a baggie. It's the

best way to keep your feces from floating away. "Aim is everything," says the astronaut Drew Feustel. "If you miss, you can create a large mess for yourself." Using the suction tubes beats having to tape a collecting bag to your behind — as the Apollo astronauts used to do.

SANDWICH STUNT

In 1965, the astronaut John Young broke the rules: He smuggled a corned-beef sandwich onto the Gemini 3 space capsule. This got him in big trouble. At the time, NASA was developing freeze-dried foods, because they were worried regular food would send crumbs flying throughout the spacecraft. NASA's space food didn't taste good, though, so Young stowed a scrumptious sandwich in his pocket. Back on Earth, Congress had a beef with the sandwich. They said Young

had wasted millions of dollars by eating it instead of the NASA space food he was supposed to test. But Young got the last laugh: In 1981, NASA added corned beef to their space menu.

STINKY-SOCK SURPRISE

Another gross thing about being an astronaut aboard the I.S.S. is that you're surrounded by tiny floating flecks of dead skin practically everywhere you go. "We have to clean it with a vacuum every single week, or else our equipment breaks down," Feustel says. Things become particularly disgusting when astronauts change their socks. You see, after being in space for two or three months, the dead skin on the bottom of their feet falls off. When astronauts remove their socks, there's an explosion of skin flakes that float around the station. Hilarious, but also ... yuck. ♦

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4. **'THIS ZOMBIE WON'T BITE, BUT SHE'LL TALK YOUR EAR OFF'**
OCT. 19, 2015

5. **'JEREMY THE LEFTY SNAIL IS DEAD. HIS OFFSPRING ARE ALL RIGHT'**
OCT. 12, 2017

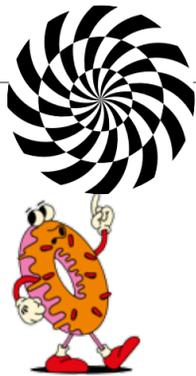
6. **'SMELLS LIKE GREEN SPIRIT'**
MARCH 3, 2013

7. **'TEETH DON'T MEAN A THING IF THEY AIN'T GOT THAT "BLING"'**
JUNE 29, 2001

8. **'THE SKI MOGUL'S RISKY RUN'**
MARCH 15, 1998

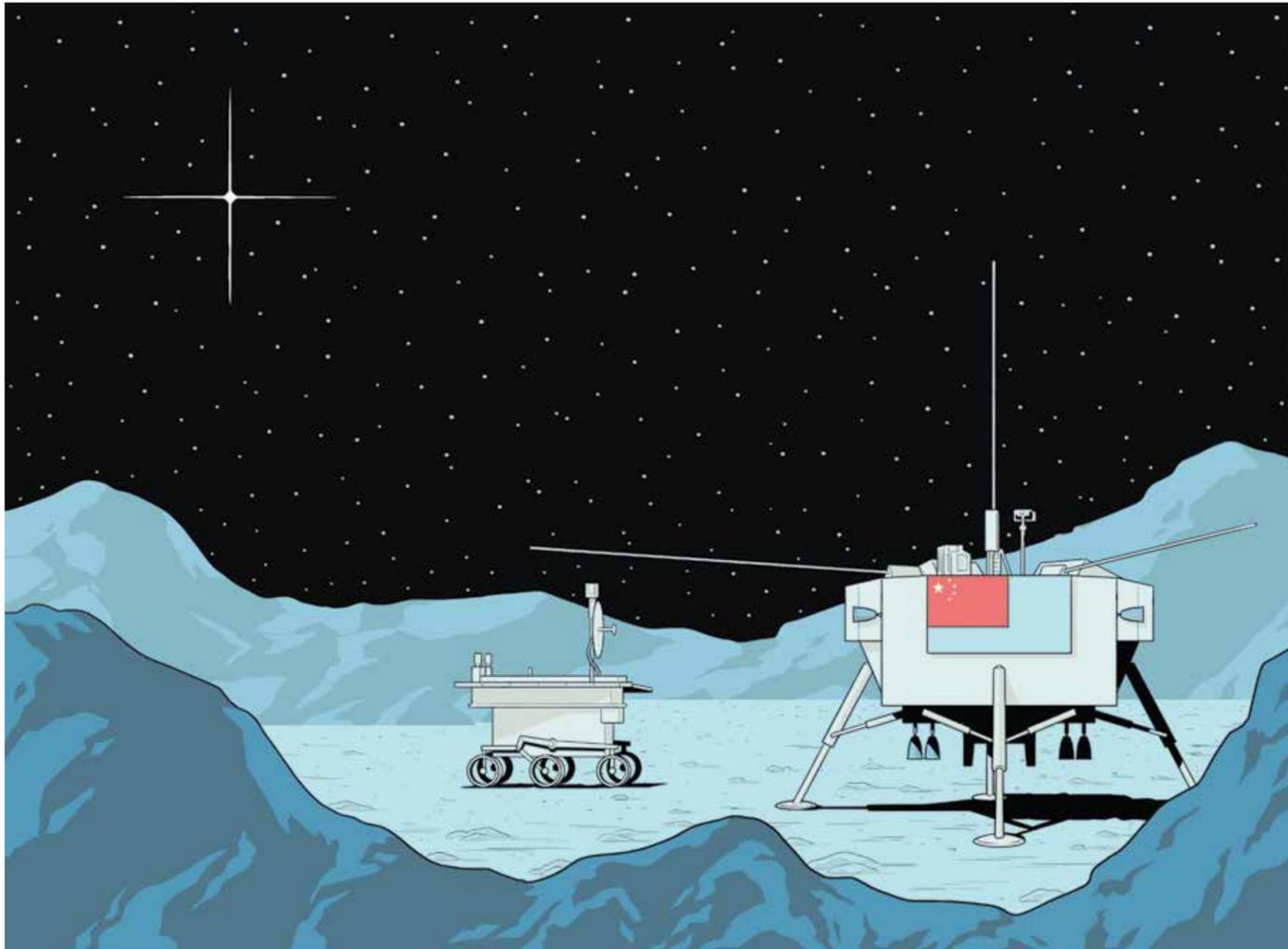
9. **'HERE COME THE SONS'**
MARCH 19, 2018

Science



ON THE OTHER SIDE OF THE MOON

BY NICHOLAS ST. FLEUR • ILLUSTRATION BY ANUJ SHRESTHA



DESPITE WHAT YOU may think, there is no such thing as the “dark side” of the moon. Both halves bathe in the sun’s light as the moon orbits around Earth. But only one side ever faces us. The part you don’t see is just farther away. Astronomers call it the “far side.”

On Jan. 2, something happened on the far side that had never happened before: A spacecraft landed there. Built and controlled by the China National Space Administration, the uncrewed Chang’e-4 spacecraft touched down near the moon’s south pole

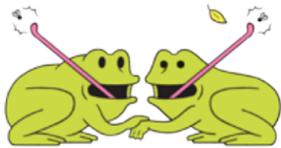
in a location called Von Kármán Crater. Twelve hours later, Chang’e-4 (named after a Chinese moon goddess) opened and released a rover called Yutu-2, or Jade Rabbit 2. It’s nearly the size of a refrigerator, and its mission is to roll around and study the terrain while Chang’e-4 stays put and analyzes the lunar rocks beneath it. Those rocks are “older than any rock we’ve found here on Earth,” says Briony Horgan, a planetary scientist at Purdue University in Indiana. “They’re a record of how the moon first formed, and what planets

might have looked like early on.” That’s one important goal of this mission: to help scientists understand how the moon was made.

Already, the Chang’e-4 mission has produced the first-ever close-up pictures from the far side’s gray, desolate surface — plus a “selfie.” The spacecraft also brought along a cotton plant to see how it would grow on the moon. But after sprouting, the poor plant froze to death in the frigid lunar night, where temperatures can drop to -310 degrees. ♦

FROGGY LOVE, AT LONG LAST!

BY SARA GOUDARZI



REMEMBER ROMEO, the lonely frog? He appeared in our Animals issue last April. At the time, he was the only known Sehuencas water frog, and he had been living the single life for 10 years in a tank at a Bolivian museum. Scientists were desperate to find him a mate to repopulate the species — so desperate that they set up a dating profile for Romeo, to raise money for expeditions to search for more frogs.

Well, good news! In December, Teresa Camacho Badani, a herpetologist, found five more Sehuencas frogs near a Bolivian waterfall — two males, two females and one that’s too young to tell yet. A female that researchers named Juliet (of course) is of mating age.

Right now, Juliet is living with the other new frogs in their own tank so the scientists can make sure they don’t have any diseases, but after that, she and Romeo will go on a toad-ally romantic first date. “We want to make sure there’s a waterfall going into the tank and prepare a special dinner of worms for them,” Camacho Badani says. She hopes that opposites attract and that the gentlemanly Romeo and the energetic Juliet will have a good date and soon be raising tadpoles. ♦

WHAT'S HAPPENING HERE? A BUTTERFLY PARTY IN MEXICO

BY KENDRA PIERRE-LOUIS • PHOTOGRAPHS BY JESSICA TANG



Even among butterflies, the monarch stands out with its bright orange wings laced in black veins and a speckling of dots. These beautiful insects live around the world, but pull off their most amazing feat in North America. In the fall, they all travel thousands of miles from Canada and much of the United States to warmer weather in Mexico and California. In the spring, they fly back. They are the only butterfly known to make this kind of two-way journey, called migration. But in the last couple of decades, most North American

monarchs — more than 80 percent! — have disappeared. Humans have cut down their forests and the milkweed plants that they depend on for shelter and food. In California, experts recently announced that they found 86 percent fewer butterflies in 2018 compared with 2017. It’s a worrisome situation, but there is still hope. In Mexico, shown above, there were more butterflies this winter — tens of millions more (yay!) — than last winter. And scientists are learning that some monarchs are spending their winters in Florida now too. Long live the monarch butterfly! ♦

HOMEMADE LAVA, FOR SCIENCE

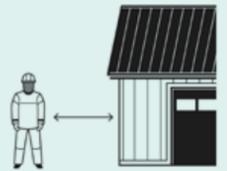
BY ANDREA POWELL

LAST SPRING, the Kilauea volcano in Hawaii suddenly erupted — and kept erupting all summer long, producing enough lava to fill roughly 320,000 Olympic-size swimming pools. People living on the island knew the volcano was active, but they were surprised by the deluge of lava that suddenly and violently began swallowing homes, roadways and even a lake. Geologists want to better predict eruptions like these, so they study real-life volcanoes and try to make computer models of them. Ingo Sonder, a volcanologist at the University at Buffalo, is trying something different: to mimic eruptions exactly as they happen by making his very own lava. “I’m trying to make it as explosive as possible,” Sonder says. Here’s how he and his team create the bubbling, molten rock.



STEP 1: GATHER VOLCANO SUPPLIES

It’s important to use real volcanic rock, so the scientists work with a company in Texas to gather rocks from an area that used to be active. They recently ordered two tons of rocks, which were loaded into a crate and shipped to Buffalo.



STEP 2: GIVE YOURSELF SPACE

Creating volcanic eruptions from scratch requires being a safe distance away from buildings and trees. No one wants to start a fire. These volcanologists head over to a special area called the Geohazards Field Station, where they can blow things up without bothering anyone.



STEP 3: TURN ON THE FURNACE

When it’s time to start melting the rocks, the scientists put on protective eyeglasses and thermal suits and dump the rocks into a giant furnace. In the beginning, it took them a few tries to figure out the right recipe. “I had to do it at least 10 times, because strange things kept happening,” Sonder says. “The lava would act funny, or there were too many bubbles created.” Eventually they figured out that heating the rocks for four hours to 2,400 degrees gives them the bubbling, red-hot magma they want.



STEP 4: PREPARE THE REACTIVE MATERIAL

Once the rocks melt into lava, the scientists use a hydraulic lift to tilt the entire furnace, pouring its contents into insulated steel boxes. Then a track system transports the boxes to another station, where they are lined up with giant syringes of water stuck into the sides.



STEP 5: STAND BACK

The researchers set the speed and amount of water they want squirted into the boxes using a computer program. Then they have only 45 seconds to get out of the way before the water turns to steam and the lava erupts, flying 15 feet in the air and landing on the ground. It eventually cools and turns into... you guessed it, rocks. By measuring the size of the explosions, the researchers hope to figure out what conditions cause violent reactions, which could allow them to better warn people living near volcanoes that a big eruption is on its way. ♦

Science

SHOT THROUGH THE SALMON CANNON

HOW DO YOU HELP THOUSANDS OF FISH UP AND OVER AN ENORMOUS DAM?

BY NICHOLAS ST. FLEUR • ILLUSTRATION BY FRANCESCO MUZZI

IMAGINE A WHITE PLASTIC TUBE. It runs about 1,000 feet long and rises hundreds of feet into the air. And inside the tube are live salmon barreling along at 25 feet per second. Believe it or not, it's a real thing! The contraption was invented by a company called Whooshh Innovations. And it's meant to give the salmon a helping hand. It all comes down to migration: Salmon spend most of their lives at sea, but when it comes time to spawn, or reproduce, they return to the rivers where they were born, swimming upstream to lay their eggs. At least, that's what they want to do. Unfortunately, humans have put some major obstacles in their path: enormous dams. Take the Columbia River, in Washington. Historically, millions of

salmon would return to it every year. But now dozens of dams clutter the river and its offshoots. "They basically blocked off hundreds of miles of prime salmon-spawning habitat," says Matt McDaniel, the manager at the Chief Joseph Hatchery. (Chief Joseph is a dam on the river, and a hatchery is like a farm for fish.) As a result, the river's salmon population has dropped, affecting other animals in turn, like the orcas that feed on them. That's where the salmon cannon comes in: The tube system was designed to carry salmon safely over those dams. Last month, a version of the system (called the Whooshh Passage Portal) was installed for testing at the Chief Joseph Dam. Here's how it works.

THE RIDE: The salmon have to be carried more than 200 feet into the air, which means gravity is working against them. The solution? The cannon uses what's called a pneumatic tube, which relies on differences in air pressure: Higher air pressure behind the fish safely propels them up through the tube.

COMFORT IS KEY: Air pressure pushes the fish through the tube at a speed of about 25 feet per second. That may sound fast, but it's actually similar to how fast they can swim. To keep them wet and comfortable, water misters spritz them every six feet, and the air inside is cooled to the same temperature as the river.

THE EXIT: The ride lasts about 40 seconds, after which the salmon are ejected into the water upstream of the dam. They may spawn right there, or they may continue upstream until they're stopped by the next dam. If the Chief Joseph salmon cannon is successful, the idea is to keep installing the devices at more dams along the Columbia River, so the salmon can make it farther and farther toward their ancestral spawning grounds. Yay!

THE ON-RAMP: The fish enter the salmon cannon from a floating barge near the foot of the dam, which has a ramp that hangs into the river. Water flows down the ramp and creates a current that attracts fish, who instinctively swim up it. "From the fish's perspective, this looks like a tributary or a creek where they can go upstream," says Vincent Bryan, chief executive of Whooshh Innovations.

SPECIES ID: After swimming up the ramp, the fish enters a tiny chamber where a scanner takes 18 high-definition photos of it from all angles. A computer then uses the photos to identify the fish's species and record its size. The whole process takes only about half a second, and it serves a specific purpose. ...

A LITTLE HELP, PLEASE?

Humans have a habit of putting up dams and buildings and roadways in places where animals are just trying to go about their business. But to compensate, sometimes we give them a hand getting from Point A to Point B — because we messed up their plans to begin with.

FENCES FOR CRABS:

Every year, tens of millions of red

crabs overrun Christmas Island, in the Indian Ocean, as they migrate from their rainforest home to their coastal breeding ground. To keep them safe, the island has built fences, bridges and underpasses that the tiny crustaceans can scurry along during their weeklong journey.

A HIGHWAY FOR BEES:

Residents of Oslo have given their local bees a leg up by creating a "pollinator passage":

a network of rooftop gardens and flower beds, strategically placed along a 10-mile stretch of the city, that ensure the honey-makers are never far from nectar.

AN OVERPASS FOR MOUNTAIN LIONS:

In many states, authorities have built highway overpasses to help animals like elk and bears cross busy roads dividing their habitats. In Southern California, conservationists recently

announced a plan to build the largest-ever wildlife overpass to help mountain lions and other animals cross the busy 10-lane Highway 101.

A WARNING FOR BIRDS:

Birds are migration ultramarathoners. But when glassy, sky-reflecting buildings sprout right in the middle of their flight paths, it can lead to fatal collisions. One solution: stickers or coatings that help birds see the building.

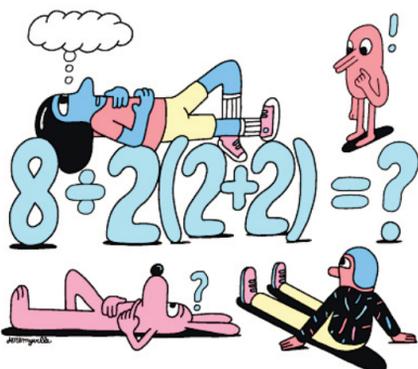
SALMON SORTER: Some fish that swim up the ramp are invasive species like grass carp, which could damage the ecosystem if they went farther up the river. If the computer identifies one of those, the system can send it back. Native fish, like Chinook salmon, are sorted by size, and the larger ones are ushered into the tube for a trip over the dam.

This illustration is not to scale.

MAD MATH

BY KENNETH CHANG

ILLUSTRATION BY JEREMYVILLE



TAKE A LOOK at the equation to the left. At first glance, it seems simple. It's just some addition, division and multiplication. Now try to solve it. Is the answer 16? Or is it ... 1? That's a question adults argued about this summer, after this equation went viral on the internet. That's right, a math problem went viral.

So, here's the deal: The premise underlying this problem is the order of operations — something that you may have learned in school as PEMDAS ("Please excuse my dear Aunt Sally"). In an equation, first you complete the math in Parentheses, then you deal with Exponents,

then you Multiply or Divide, and lastly Add or Subtract. The order of operations is important, because the answer can change depending on whether you multiply first and then add, or vice versa. So by following PEMDAS, people come up with the same answer.

Except in this case. Everyone agrees that you solve $2 + 2$ first, because that's in parentheses. So now we have $8 \div 2(4)$. Many people saw that as the same as $8 \div 2 \times 4$. If you solve it from left to right, you'll get an answer of 16. The catch is that when you get to higher math, like algebra, implied multiplication — i.e., the $2(4)$

— sometimes takes priority. And in that case, you'd get an answer of 1.

Don't worry if you're confused. The problem isn't your brain. It's how this expression was written: to be misleading, which is exactly the opposite of what it should do. As math becomes more complicated, the more critical it becomes to communicate clearly. That's why after elementary school, division is generally written as fractions; in this case, the problem could be expressed as $\frac{8}{2} \div (2 + 2)$ or $\frac{8}{2(2+2)}$, depending on what was intended. Either way, the answer — 16 for the first fraction; 1 for the second — is crystal clear. ♦

International



Huge fires began to rage across the Australian continent in September — and some are still burning, destroying homes and forests. The images above are all from the southeastern state of New South Wales in December and January.

HOW BUSHFIRES DEVASTATED

AUSTRALIA

BY NICHOLAS ST. FLEUR · PHOTOGRAPHS BY MATTHEW ABBOTT

OVER THE LAST few months, fire in Australia has been one of the biggest news stories around the world — you've probably seen photos of the destruction. Bushfires are a natural occurrence during the Australian summertime, which runs from December through February, but this fire season has been much worse than usual. The fires began to roar in September. Then in December, a record-breaking heat wave added more fuel to the flames. By January, two tremendous wildfires in the southeastern states of New South Wales and Victoria had merged together, forming a "megafire." "Because it has been unusually hot and dry, the wildfires are easier to start, and they are burning larger areas, and they are harder to control," says Jennifer Marlon, a research scientist at the Yale School of Forestry & Environmental Studies.

As the bushfires roared across the continent, they scorched landscapes, incinerated ecosystems and turned the sky red with smoke and ash. Hundreds of thousands of people were urged to evacuate their homes as fires approached, and the Australian Navy had to send in ships to rescue 1,000 people who sought refuge on a beach. Firefighters from other countries rushed in to help battle the blazes, and the international community has offered millions of dollars of aid to help Australia recover. Recent rainfall has helped suppress some fires, but because the next few weeks will probably continue to be hot and dry in some areas, the danger isn't over. The disaster has also sparked thousands of citizens to take to the streets in protest against politicians unwilling to combat climate change — which, Marlon says, "has made these fires much worse than they would normally be." ♦

THE BUSHFIRES BY THE NUMBERS

'THE ENTIRE SKY GLOWED BLOODRED.'

BY JESSICA TREGELLAS, 12

I LIVE in Mallacoota, a remote coastal town in southeast Australia. In late December, when I heard that dangerous bushfires were spreading close by, my family made a fire plan. We packed stuff we'd need if we had to evacuate, like masks, gloves, head lamps, sturdy shoes and water bottles. If we had to, we'd camp near a lake two kilometers away. We could wade into the water if it got bad. I asked my dad how we'd keep our horses safe — I couldn't worry about myself until I knew Romeo and Buddy would be OK. We decided that if we evacuated, we would spray-paint our phone number on the horses' sides and open the gates so they could escape.

A few days later, a lightning strike started a fire in a nearby forest. It was headed straight for us. I freaked out. I told my dogs, Amy and Googie, that I would keep them safe. We put our plan into action and loaded the dogs, my guinea pigs and my bunny into the back of the car. My friend Rowena held the fish bowl.

The lake was crowded. We set up an Australian bedroll called a swag, but I was too petrified to sleep. In the morning, the sky was black and smoky. Soon the entire sky glowed bloodred, and a hot wind picked up. Ash sleeted down. My eyes stung. We moved to the edge of the lake as the fire got closer. Amy cried and howled. But then the winds changed and blew the fire in another direction. We drove home later that day, past burning trees and the remains of a friend's home. When we pulled up our driveway and saw that our house was still standing and that the horses and chickens were safe, I felt so relieved — just really lucky. As told to Kitson Jazyuka

1 BILLION MAMMALS, REPTILES AND BIRDS ARE ESTIMATED TO HAVE DIED IN THE FIRES SINCE SEPTEMBER. ON KANGAROO ISLAND, OFF THE CONTINENT'S SOUTHERN COAST, A THIRD OF THE KOALAS AND KANGAROOS ARE THOUGHT TO HAVE PERISHED.

107.4° WAS THE AVERAGE TEMPERATURE IN AUSTRALIA ON DEC. 18, MAKING IT THE HOTTEST DAY EVER RECORDED ACROSS THE CONTINENT.

33 PEOPLE, AT LEAST, HAVE BEEN KILLED IN THE FIRES. FIREFIGHTERS ARE AMONG THE DEAD, INCLUDING THREE AMERICANS WHO TRAVELED TO AUSTRALIA TO HELP THE EFFORT.

'THERE WAS NOTHING LEFT.'

BY GABRIEL KAM, 16

OUR PROPERTY, in Balmoral Village, New South Wales, was a green forest that was home to lyrebirds, lorikeets, kookaburras, wombats and koalas. I could wander into the gully and find myself staring into the eyes of a wild kangaroo, then watch it hop away.

We knew the bushfire was in our area, but I wasn't worried. We had defended our home against fires before and hoped this one would stay away. We cleared shrubs and filled water buckets to prepare, just in case.

A week before Christmas, the fire came at us from three directions. It was late afternoon. We could see plumes of smoke as the fire crowned the trees. It roared, crackled and hissed. Branches snapped. Then the wind picked up and changed direction. It was as if I had blinked and the fire was through the gully and outside the laundry room. We hosed the deck and threw water on the fire, but it quickly burned through a thick wooden door. It was time to leave. I grabbed my cats, put them in carriers and got in the car along with essentials we had packed. Saving our house was impossible now. My parents and I sheltered at a nearby fire station along with a lot of our neighbors.

Seeing our home after the fire was hard. There was nothing left. Even all the moss and dirt had turned to ash and blown away like everything else. A few trees still stand, but they are like charcoal. We see the remains of burned animals on the road. I don't think people outside Australia understand the scale and impact of the bushfires here. Everyone here has been affected in one way or another. As for our home, we'll never give up on rebuilding. It's nonnegotiable. As told to Kitson Jazyuka

2,500 OR MORE HOUSES HAVE BURNED DOWN. MORE THAN 240,000 RESIDENTS WERE URGED TO EVACUATE THEIR HOMES TO ESCAPE THE DEVASTATION.

31.1 MILLION ACRES OF BUSHLAND HAVE BEEN DESTROYED, AN AREA ABOUT THE SIZE OF MISSISSIPPI.

58,000 FEET UP, YOU COULD STILL DETECT THE SMOKE FROM THE BUSHFIRES IN THE AIR — IT ENTERED THE STRATOSPHERE. THE HAZE DARKENED THE SKIES AS FAR AS SOUTH AMERICA AND COMPLETELY ENCIRCLED THE WORLD.